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Heating Piping & Air Conditioning

DESIGN
INSTALLATION
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INDUSTRIAL
COMMERCIAL
INSTITUTIONAL AND
PUBLIC BUILDINGS

APRIL ★ 1948

107 — *Journal Section of the American Society of Heating and Ventilating Engineers*

Why double glass windows are being installed in air conditioned glass block building . . . . page 69

Save Heating . . . Page 72

Aluminum Piping and Its Use . . . Page 78

Ventilating Employee Cafeteria . . . Page 98

Complete Contents of This Issue . . . Page 67

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Lost time... for the last time

when you install

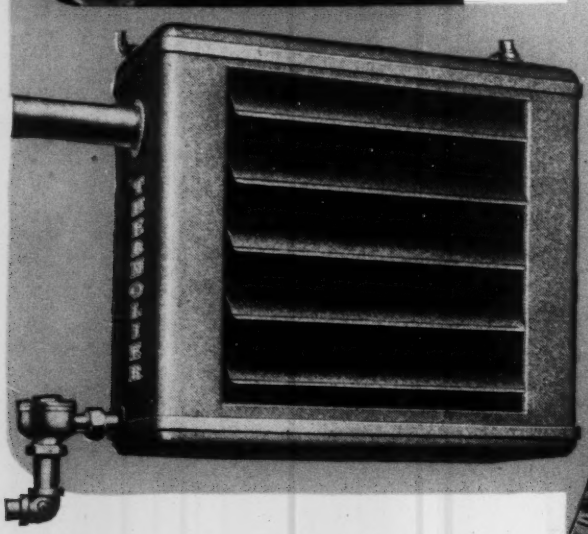
THERMOLIER UNIT HEATERS

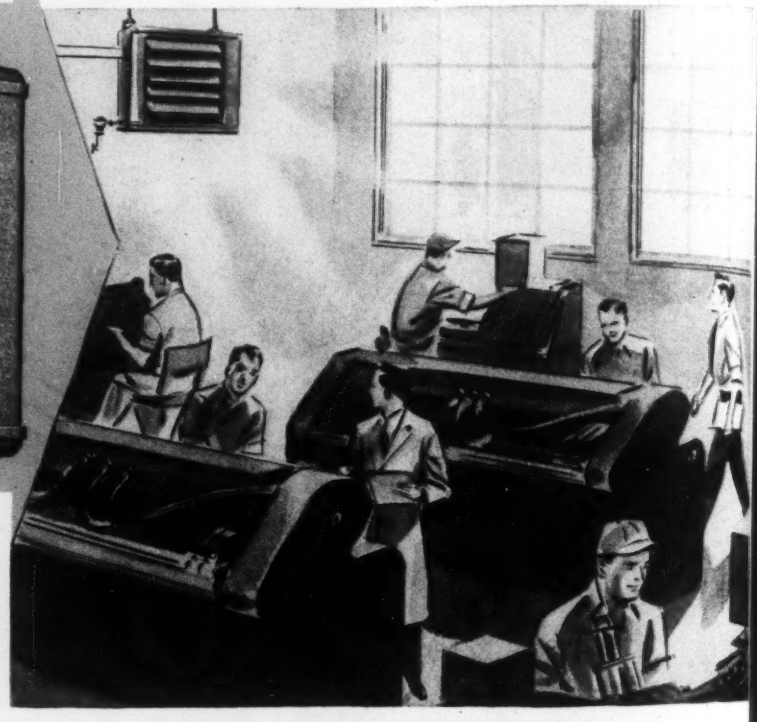
Your fuel bills may make you wonder why your plant wasn't comfortably heated during the past winter. Lost time due to inefficient heating can cut big slices off any production schedule. Heat is balky stuff that hangs around ceilings. It's largely wasted unless you drive it where you want it.

Now is the time to do something about it for next winter. Install Thermolier Unit Heaters. Materials and labor are available and there's sufficient time to do your job right.

If you wait till fall you may be caught short. Get in touch with Grinnell or your local Thermolier Distributor at once. We can show you how Thermoliers distribute heat *where you want it* and often save up to 27% of scarce expensive fuel.

Thermolier's 12 points of superiority make it the logical choice for efficient trouble-free operation—give you full value from fuel dollars. Thermolier Catalog 6-E tells the whole story. Grinnell Company, Inc., Providence 1, R. I.





WHAT THERMOLIER'S SUPERIOR FEATURES MEAN TO YOU

- Maximum radiation from all surfaces at all times, because exclusive internal cooling leg provides continuous drainage of condensate. This feature also permits use of a thermostatic trap, the simplest and least expensive type of trap.
- Quiet, trouble-free operation. Pronounced pitch of the tubes assures complete drainage of condensate. Annoying and destructive water hammer is eliminated.
- Safety and durability are assured with leak-proof tube-to-header construction.
- Damaging strains caused by expansion and contraction are eliminated by "U" type expansion tubes.
- Additional desirable advantages from eight other features.

GRINNELL

WHENEVER **PIPING** IS INVOLVED

THE EDITOR'S PAGES

"LABOR" MEANS WORK DONE, NOT PEOPLE

R. Stafford Edwards, president of Edwards and Co., Inc., believes that the adoption of a new psychological approach applied to the problem of improving relations between employers and employees may seem to be a relatively unimportant factor but can be of great benefit. His suggestion is simply that we stop using the word "labor" except to signify the work done.

Then, "we should stop calling the man a 'worker' and refer to him as an 'employee,' or, in a mass, 'employees.' When we need to refer to the organized mass we should stop talking about 'labor' or 'organized labor' and talk about 'unions' because that represents the truth. We should, therefore, stop talking about 'labor relations'—we mean 'employer-employee relations'."

He would like to see the phrase "management" abandoned as much as possible because it pictures to the average mind a small, powerful group of men as opposed to the "employees." There are few instances where the word "employer" can't be substituted, he believes.

STOKER SALES INCREASE, SMA REPORTS

Stoker sales by stoker manufacturing firms in 1947 totaled 68,908 units of all sizes and types compared to a total of 190,918 units in 1946 and 130,824 in 1945 according to a statement released by the U. S. Department of Commerce. Previously the Stoker Manufacturers Association had estimated 1947 total unit sales by factories at 68,500. The association also estimated that sales by dealers to users totaled approximately 110,000 to 120,000 units last year, due to the fact that distributors and dealers had a heavy inventory of completed stokers on hand at the beginning of 1947, most of which were sold and installed during the year. This was the major factor in the extremely light factory sales of stokers throughout 1947, according to the SMA.

Preliminary reports from the field also indicate that stoker sales to date this year are nearly double the sales for the same period in 1947 and numerous manufacturers report that orders from stoker distributors and dealers show substantial gains over last year, says the association.

RIGHT MATERIAL, RIGHT AMOUNT, RIGHT PLACE

Good advice to everyone is offered in a new movie—use the right material of only the right amount in only the right places.

This is the theme of a 15 minute film aimed to assist the designer and engineer to use arc welded steel in the design of all types of machinery in many hundreds of different industries, and released by The Lincoln Electric Co., Cleveland. Its title is Designing Machinery for Arc Welding.

OUTPUT TOPS ALL BUT ONE WAR YEAR

With shipments of its products at a record level for peacetime, net sales billed by the Westinghouse Electric Corp. for 1947 amounted to $703,154,334.

Reporting the year's work, following a meeting of the company's board of directors, Gwilym A. Price, president, pointed out that "in dollar value, our 1947 shipments exceeded all previous records in peace or war with the single exception of the peak war production year of 1944, when our output totaled $830,480,435."

Net income in 1947 amounted to $48,806,417.

1947 NET SALES SET PEACETIME RECORD

More than 60 new instruments and control systems were announced by the Minneapolis-Honeywell Regulator Co. during 1947, Harold W. Sweatt, president, told stockholders in the annual report mailed last month.

Net earnings, which have been previously released, totaled $6,693,509 for 1947, compared with $5,119,143 the year previous. Net sales established a new peacetime record and totaled $60,596,021, compared with $45,940,081 in 1946.

The increase in sales, which was general throughout major company divisions, resulted in an approximately equal percentage increase in net earnings, Mr. Sweatt said.

Slightly more than half of the company's total sales during the year were made up of products newly designed or redesigned since 1939, the report states. Today the company spends nearly as much for research and engineering as the company's entire net income 10 years ago.

The company's air conditioning controls division in 1947 completed the largest sales year in its 17 year history, Mr. Sweatt reported.

HOW TO FIGURE HEAT PUMP COIL SPACING

M. S. Oldacre, of the Utilities Research Commission, reported a new method of determining the proper spacing of coils buried in the earth as a heat source for heat pump installations, in a talk before the Illinois chapter of the American Society of Heating and Ventilating Engineers last month.

On one job he visited, the owner told him the coils were spaced the distance they were because "that was the width of the man that dug the trench."

HOT SPRINGS TO KEEP HIGHWAY ICE-FREE

The Oregon State Highway Commission proposes to use pavement heating at Klamath Falls.

There are numerous hot springs in this area, and hot water of a temperature exceeding 165 F can be obtained by drilling wells. It is proposed to use this hot water as a source of heat to prevent the formation of ice on the pavement. This is only being done for a section of about 400 ft in length which is on a rather steep grade.

The water will not be pumped directly through the heating coils in the pavement as the hot water has a high mineral content. A heat exchanger—which consists of pipe inserted in the well and containing mineral-free water—will be used.

In an article in the December 1940 HPAC, Erwin L. Weber described a panel heating system for a service and repair garage at Klamath Falls using hot water obtained from a 490 ft well.

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THE EDITOR'S PAGES

NET SALES LAST YEAR LARGEST IN HISTORY

Consolidated net sales last year were the largest in the history of the organization according to the recently released 1947 annual report of the Trane Co., La Crosse, Wis. and its subsidiary, Trane Co. of Canada, Ltd. In 1947, sales amounted to $20,956,830 as compared with $13,839,855 for the year 1946.

The consolidated net income as reported by Reuben N. Trane, president, was $2,102,234 in 1947, while the 1946 net income was $1,187,921.

The increase in net sales was made possible by the utilization of expanded production facilities which resulted from a program of expansion started in 1945 and completed in early 1947.

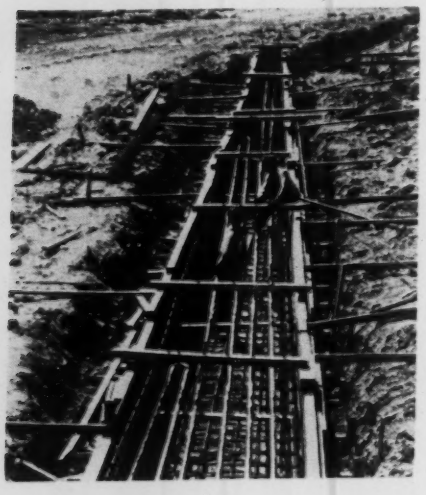
The company has completed negotiations for a new branch factory at Scranton, Pa., which will be used at the outset for the manufacture of convector-radiators to meet a rapidly increasing demand for this product in eastern markets.

NEW PLANE HANGAR HAS SNOW MELTING STRIP

The first snow melting system to be installed at an airport is said to be the one for the entryway of a large new hangar at Chicago for American Airlines. A system of wrought iron pipes, embedded in the pavement beneath doors of the hangar, carries hot water, with antifreeze added, to keep the surface temperature above the freezing level. A strip 7 ft wide and 514 ft long thus remains clear of snow and ice throughout the winter months, so that aircraft may enter and leave the hangar easily regardless of weather conditions.

The snow melting system, consisting of nearly two miles of 2 in. and 2½ in. pipe, is fed hot water from a boiler in the hangar, the water returning to the boiler to be reheated and recirculated after coursing through the serpentine coils of the system. The water is continually re-used throughout the snow melting season; in the spring it may be drained out, to be replaced in the fall.

A strip 7 ft wide and 514 ft long at the entryway of a new American Airlines hangar is heated to keep it clear of ice and snow



DEAN PEEBLES TO RETIRE THIS YEAR

James Clinton Peebles, dean of engineering at Illinois Institute of Technology, has announced he will retire at the end of August after an association with Illinois Tech and its predecessor institutions which extends over nearly half a century.

Early in his career, Dean Peebles began a study of thermal insulation. For more than 30 years he has been a leading research engineer in commercial and domestic insulation.

He designed and built an instrument for measuring heat flow, since adopted as standard by the American Society for Testing Materials and used as standard equipment in research laboratories throughout the world.

Dean Peebles was a pioneer in research for heating by solar radition, particularly in the proper design of houses to make maximum use of solar heat.

IRON AND STEEL SCRAP DRIVE URGED

There is a national shortage of iron and steel scrap for use at the steel mills and foundries. The winter decline in the supply of this scrap metal resulted in the shutdown of some open hearth furnaces. The resulting shortages of steel mill and foundry products are being felt by manufacturers which require those products. In some cases these shortages have already brought factory shutdowns.

Accordingly, you are urged to take the following actions:

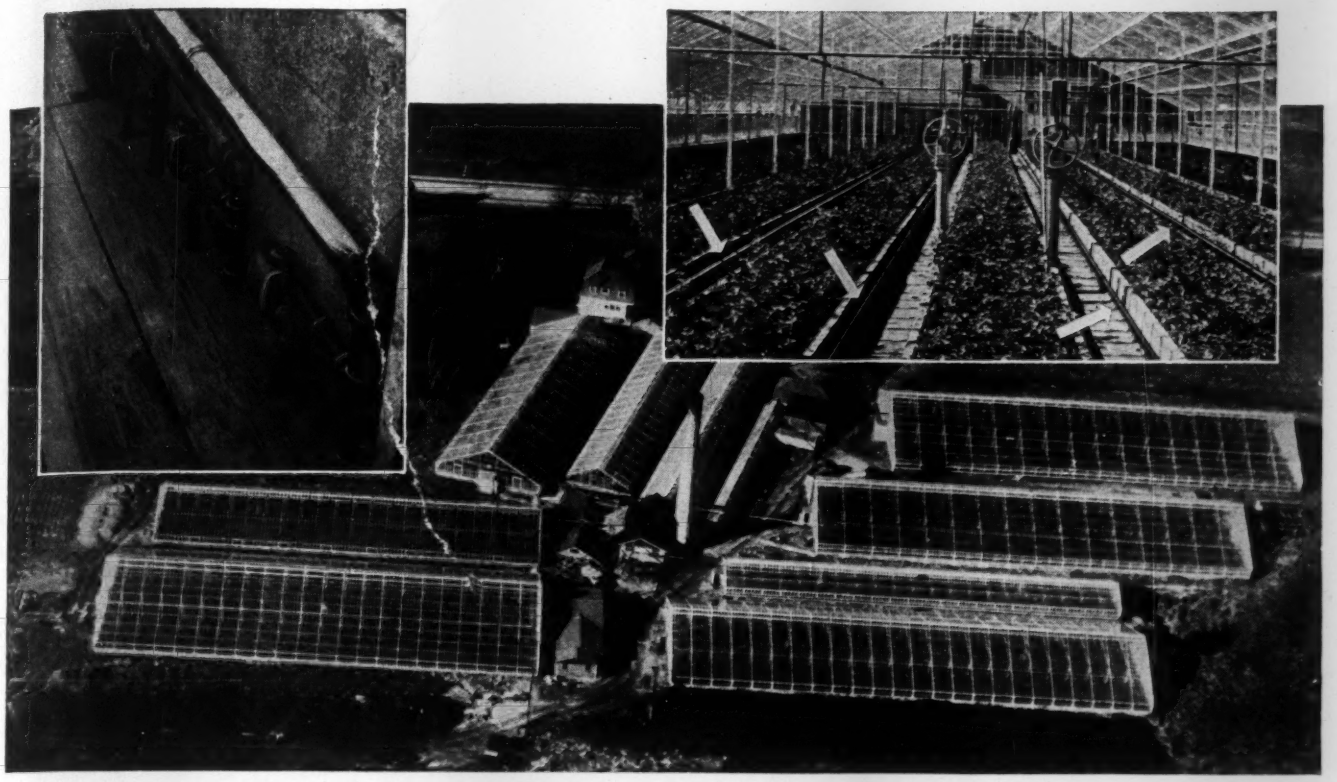
A) In your company—
   1) Collect and classify all scrap generated in your manufacturing operation and dispose of it promptly in your regular way.
   2) Conduct a thorough scrap clean-up campaign within your plant and properties.
   3) Consider scrapping obsolete or unusable equipment (such as outmoded tools, dies, jigs, molds, and parts) or dismantling unused buildings.
   4) Dispose of stocks or replacement parts for which you no longer have use.
   5) Follow-up regularly.

B) To others—
   1) Write your suppliers letters covering the above points.
   2) Write your branches and dealers, and even customers, similar letters.

GAS COMPANIES USING CATALYTIC CRACKING

New and improved processes for manufacturing gas, developed under intensive research programs carried on by the gas industry today are in operation, adding as much as 35 percent to the peak load production of some manufactured gas companies, H. Carl Wolf, managing director of the American Gas Association, announced recently. New methods of producing utility gas from fuel oils have passed the experimental stage and now are in operation. Catalytic gas cracking plants are operating at Riverhead, L. I., and Chester, Pa. Many other gas companies have established propane, butane, and natural gas standby facilities for mixing these fuels with manufactured gas to meet peak loads.

Catalytic cracking—long associated with the oil industry—represents a new approach to gas industry problems, not only in the type of gas produced but also from the standpoint of flexibility and other economic factors. Catalytic gas cracking plants can be installed at strategic points along the systems of manufactured or natural gas systems to produce and feed into the system gas of the same Btu value and gravity as that produced by other plants of the system.



Chevalley Greenhouses at Bayport, Long Island, as seen from the air. Insert at left shows how a separate Webster Heavy Duty Trap, protected by a Webster Strainer, serves to drain each separate long pipe line. Insert at right shows the pipe lines thus drained running alongside the growing troughs.

"Strictly Roses"

Chevalley Greenhouses at Bayport, Long Island, grow nothing but roses. At any given moment this successful business has a substantial investment which could be greatly impaired by sudden temperature changes.

Chevalley fully appreciates the importance of reliable, flexible and fool-proof heating. They provide this heating through steam with a separate steam line along each side of each trough, as shown above at right.

Before selecting Webster Steam Heating Equipment, Chevalley made a thorough study of the various types of traps available, visiting and examining many greenhouse installations. By ordinary engineering standards figuring the amount of surface in each coil, only a small thermostatic trap would be required. Chevalley determined that the preferred solution is a separate Webster Series 26 Float and Thermostatic Drip Trap on the discharge of each long pipe coil.

When the sun is on the glass there is no heat in this piping. But let there be a clouding over of the sun and a drop in temperature and Chevalley requires instant heat the full length of the pipe coils.

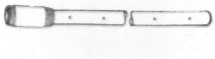
Regardless of how suddenly steam is turned on to any pipe coil, a Webster Series 26 Trap provides immediate full drainage of condensation, big overload capacity when cold, and elimination of any possibility of damage through water hammer. Satisfactory operation is assured regardless of whether the control of steam supply is manual or automatic.

Webster worked with Chevalley Greenhouses in solving this problem and appreciates their courtesy in permitting us to tell the story in our advertising. Webster men have helped to solve greenhouse heating problems for more than thirty years. If you have a greenhouse heating problem write us about it. We will pass it on to the Webster Representative nearest you. He will be glad to work on it with you.

WARREN WEBSTER & CO., Camden, N. J.
Representatives in principal U. S. Cities : : Est. 1888
In Canada: Darling Brothers, Limited, Montreal

Webster
HEATING SYSTEMS

Some Items of Webster Equipment For Greenhouse Heating

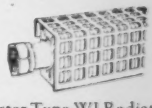


Webster Manifold Coil Orifice Fitting balances steam distribution in pipe coil installations, resulting in partial heating throughout entire length.

Webster EH-10 Moderator Control Cabinet and Outdoor Thermostat provides automatic heat variation.

Webster Float and Thermostatic Drip Traps provide immediate full drainage of condensation, big overload capacity when cold.

Webster Thermostatic Radiator Trap—the world's best known radiator trap.



Webster Type WI Radiation. One line does the work of an entire manifold coil.

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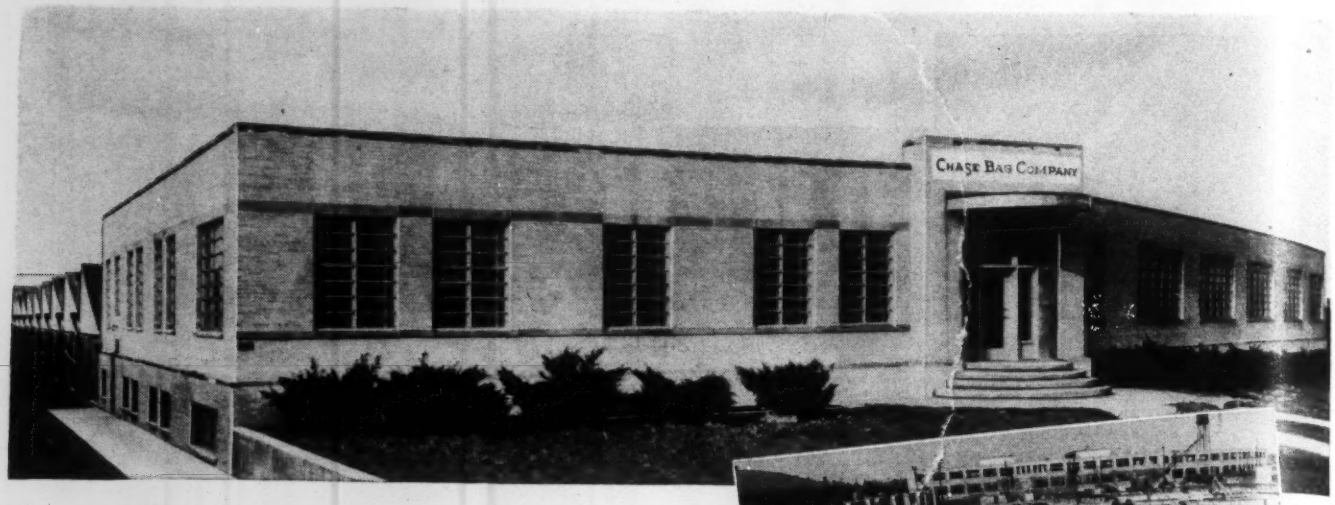

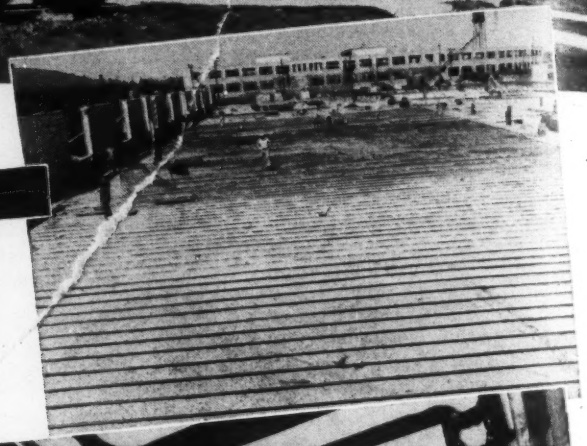

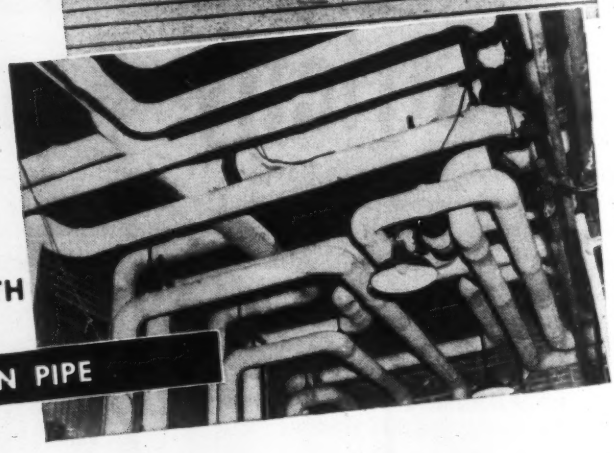

MORE BIG INDUSTRIAL INSTALLATIONS

FOR RADIANT HEATING WITH BYERS WROUGHT IRON PIPE

The Chase Bag Company recently celebrated its 100th anniversary by completing three new factories and a factory addition. All of these modern structures have radiant heating, and more than 25 miles of Byers Wrought Iron pipe, in sizes from 1¼ to 5-inch, were used in the various installations for the heating coils and for auxiliary lines.

MAXIMUM EFFICIENCY—MAXIMUM COMFORT

The illustrations show typical design and procedure. Pipes were welded into grids for manufacturing, warehouse and garage areas, formed in sinuous coils for second floor areas. Hot water is used for heating. The building was divided into zones with individual circulators used for each. Shortly after one building was completed, outside temperatures dipped to 15° below. Comfort conditions within the plant were reported as "excellent."

UNIQUE PROPERTIES

The almost universal use of wrought iron pipe for radiant heating results from engineer recognition of its unusual advantages. It is easily formed and welded. It has high heat emission. It expands and contracts at practically identical rates with concrete, avoiding the danger of thermal cracks, and loss of bond. Finally, its superior corrosion resistance has been conclusively demonstrated.

HELPFUL LITERATURE

Our bulletin, "Byers Wrought Iron for Radiant Heating", gives complete technical information on calculation, design, and layout. Ask for a copy.

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, Salt Lake City, Seattle, San Francisco. Export Division: New York, N.Y.

CORROSION COSTS YOU MORE THAN WROUGHT IRON

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GENUINE WROUGHT IRON
TUBULAR AND HOT ROLLED PRODUCTS
ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS

Heating Piping & Air Conditioning

with which is merged the Aerologist

Design, Installation, Operation, and Maintenance: Industrial, Commercial, Institutional, and Public Buildings

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Published monthly by the Keeney Publishing Co., 6 North Michigan Avenue, Chicago 2, Illinois. Telephone: State 6916. Subscriptions: U.S. and possessions, $3.00 per year; Canada, Cuba, Mexico, Central America, South America, $4.00 per year; other, $6.00. Current copies, U.S. and possessions, 35c each; back copies, 60c each. January 1948 issue, $1.50 per copy. Member Audit Bureau of Circulations and Associated Business Papers, Inc.

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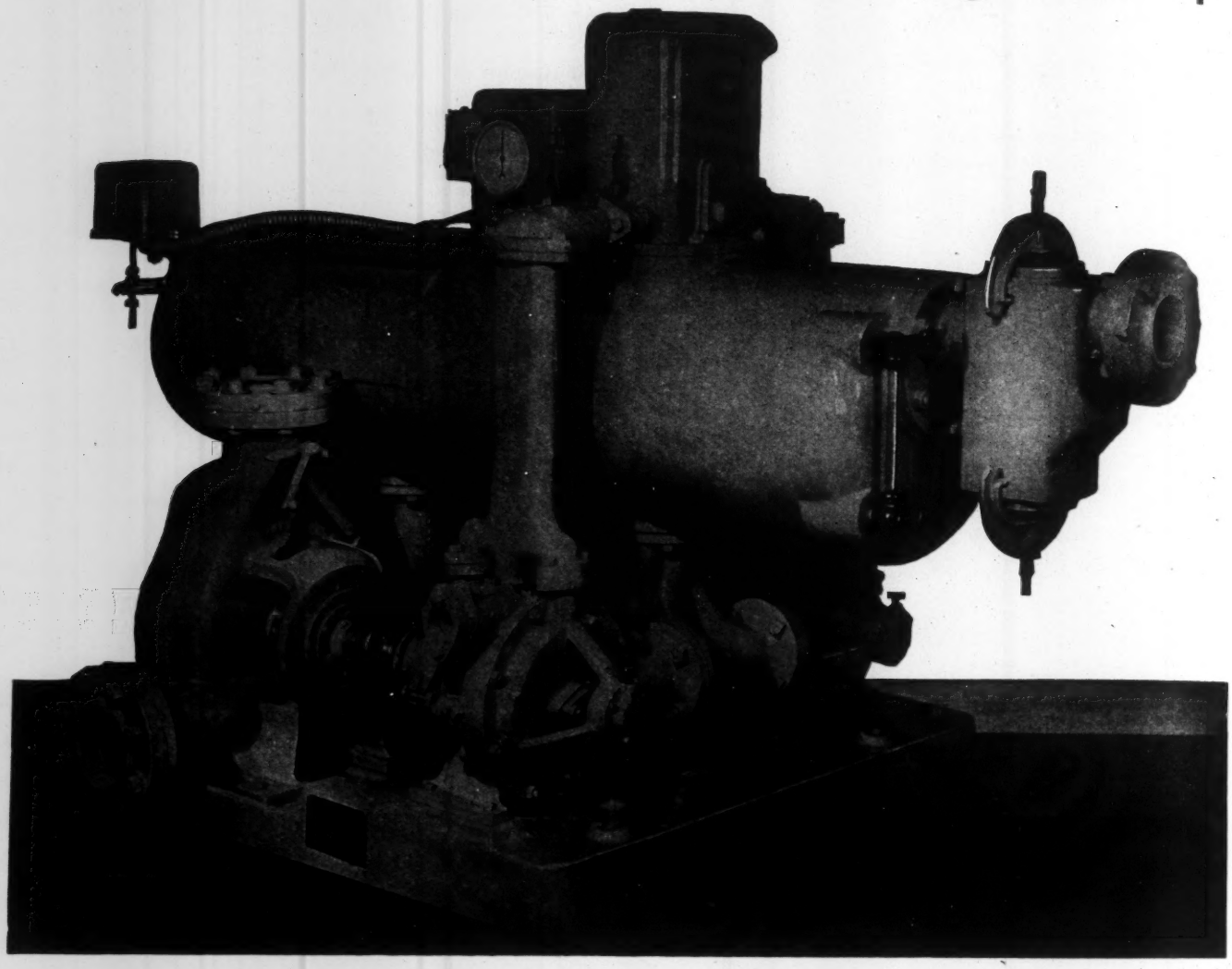
Where Heat Must Not Fail– Install this SAFE Heating Pump!



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is entirely independent of electric current failure, and continues to operate as long as there is steam in the system.

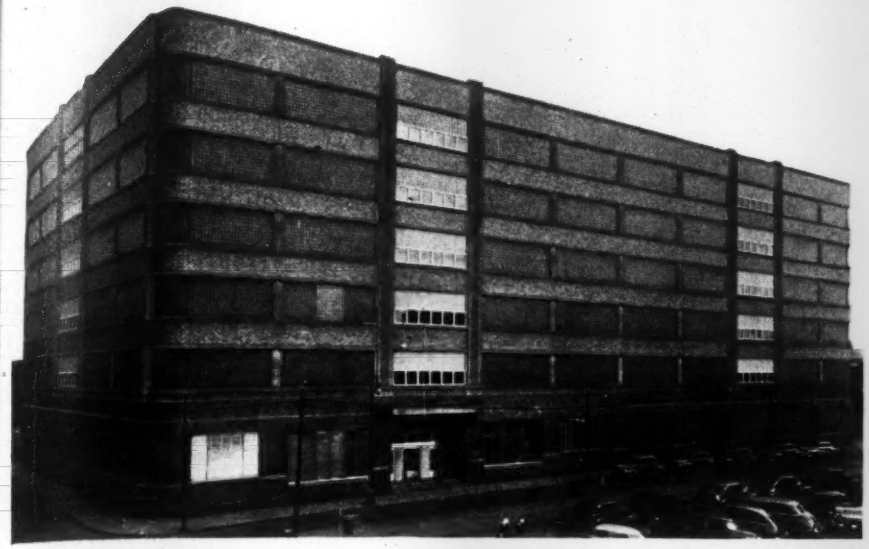
More than that, the Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump.

Greater savings still are effected by the Vapor Turbine in the system, for the reason that this pump operates continuously. It is the only pump that can do this with economy. Continuous operation means uniform circulation, and uniform circulation saves steam.

The Nash Vapor Turbine has but one moving part, rotating in the casing without metallic contact, and requiring no internal lubrication. Quiet, compact, and trouble-proof. Bulletin A-290 is free on request.

THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.



Double glass windows are used in conjunction with glass block at The Detroit Edison Co.'s air conditioned service building. Structure was originally windowless.

Air Conditioned Building Has Double Glass and Glass Block

PAUL G. HEIDMAN, superintendent of the building operations department, The Detroit Edison Co., describes the installation—and the reasons for it—of double glass windows in the company's 10 year old, completely air conditioned service building, which was originally entirely of glass block and brick construction. Employees do like to be able to look out, he says, but conventional windows make it impossible to provide the maximum comfort conditions for employees near them

MORE THAN LOCAL interest was shown in the event when—in 1938—The Detroit Edison Co. moved part of its activities into a new, six story, glass block service building. Magazines and newspapers publishing articles about the structure included:

Heating, Piping & Air Conditioning.....October 1937, April 1938, October 1939
Architectural Forum .....December 1938
Buildings and Building Management.....August 1938, May 1944
Chicago Herald-American....October 2, 1939
The Constructor .....December 1937
Detroit Times .....May 15, 1938
Electrical World .....June 4, 1938
The Magazine of Light .....Summer 1938
Real Estate Record .....August 6, 1938; August 5, 1939
Skyscraper Management .....July 1938
Transactions of the Illuminating Engineering Society .....February 1939

Coffer lighting, air conditioning, and a high factor of space utilization were some of the innovations in this new building. The employees in the building (approximately 1300) could not see out-of-doors except from the restrooms located on the sixth floor.

Now, after 10 years of occupancy, we are being asked why we installed double glass windows in part of this building last fall. We hear such questions as:

"Did the employees object to working in a building where they could not look out?"

"Did the pressure from the employees become so great you had to do something about it?"

"Why didn't you install these windows in the first place?"

"Why did you use glass block almost entirely in the original job?"

Many of these questions answer themselves when sufficient background information is made available.

When the service building was designed, one of the first decisions made was that the building would be completely air conditioned. To accomplish this, extensive duct work, fans, equipment, and controls were necessary, and consideration was given to the idea of doing all the heating through this system without the addition of direct radiation.

An installation of forced air heating had been made some years before in an addition to the older main office building of the company. The results of this previous installa-

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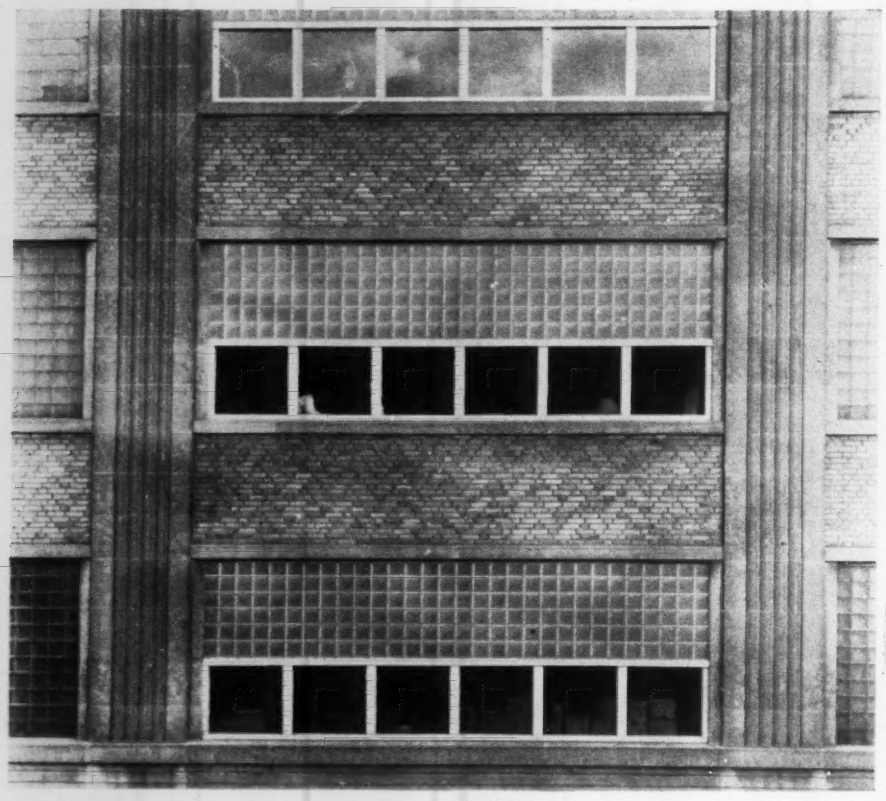

Installation of windows in 26 out of 142 bays has been completed, and the balance are expected to be done in the near future

tion had been far from satisfactory. Most of the difficulties encountered in the earlier installation were caused by the windows.

Single glazed swinging windows had been used. In winter, the temperature of the glass was so low that persons sitting near the windows were chilled by being exposed to the cold glass surface. The cold glass also caused a draft down the window which was greater than the exhaust system could handle and as a result the cold air spilled into the room. Although the windows were weatherstripped, the air leakage around the sash was considerable and became worse as time passed.

We felt that a fixed double glazed window with an adequate exhaust system to remove the downdraft would make it possible to do all the heating with the air conditioning system and thereby eliminate the use of direct radiation. A double glazed window would result in higher temperatures of the inside glass, thus decreasing the heat lost from individuals by radiation and would also decrease the draft down the glass. By installing the windows in a fixed position, they could be sealed in such a manner as to make the infiltration of air a negligible factor.

Various types of double glazed windows were investigated at that time, but in all cases the seal in which the glass was set failed; as a result, air leaked into the space between the panes. This caused fogging of the windows in cold weather and a gradual accumulation of dust on the inner surfaces.

With no satisfactory double glazed windows apparently available at that time, it was decided to use glass blocks for the new service building.

Heat Loss Through Glass Block, Double Windows

The heat loss through the glass block is practically identical to the heat loss through fixed double glazed sash. The heat transmission coefficient, in Btu per hour per square foot per degree temperature difference for glass block is 0.46, for fixed double glazed sash is 0.45, and for single glazed sash is 1.13, according to the Heating, Ventilating, Air Conditioning Guide, published by the American Society of Heating and Ventilating Engineers.

The actual cost of steam for heating the service building with steam at $1.00 per 1000 lb is $3960 for a normal heating season. If the consumption for the service building were the same as for a typical office building in the Detroit area the cost would be $8800. The actual steam consumption per 1000 cu ft of heated space in the service building is only 0.267 lb per degree day.

In comparison, the new installation of fixed double glazed sash windows with heat absorbing glass in the outside pane theoretically should not affect the heating, as there is very little difference in the heat loss through the double glazed sash and the glass block. On sunny days, more heat will enter the building through the double glazed sash but this will be of little importance because of the relatively small number of hours of sunshine in Detroit during the heating season.

Actually, some increase in heating cost is expected. Inside venetian blinds have been used in winter to reduce the radiation from persons sitting near the windows to the relatively cold glass. It is probable that venetian blinds will be used less often for this purpose with the clear glass windows, and as a result higher temperatures will be carried in the occupied space.

Another factor—harder to measure—will be the psychological effect of looking out of the window and feeling cooler because of a blizzard outside. We have had calls to raise temperatures which we believe were a direct result of this psychological factor.

Some Increase in Cooling Load Expected

Some increase in cooling load will result because of the installation of the new windows. This increase in load is due to the increase in sun load that will enter the new building through the new windows. From the best information available, an increase in heat transfer of approximately 35 Btu per hr per sq ft of glass window installed on the west exposure is to be expected at 3:00 p. m.

This would result in an increase of 20 tons or approximately 5 percent in peak load if windows were installed in all bays. Assuming that the venetian blinds are not used with the new windows, an increase of approximately 38 tons of cooling

load would therefore be expected.

It is a recognized principle that in cold weather persons sitting near windows or walls radiate considerable heat to the cold windows or walls. This causes a feeling of coolness lower than that corresponding to the air temperature of the room. In summer, when the windows or walls may be above the room temperature, the reverse is true and a feeling of warmth above that corresponding to the air temperature of the room is produced.

In summer the temperature of the inner glass of the new windows is expected to be as much as 7 deg lower than the temperature of the inner surface of the glass block and therefore the feeling of warmth will more closely correspond to the air temperature of the room. Just how much will be gained from this lower glass temperature is indefinite, because the venetian blinds were extensively used to offset the effect from the glass block and we do not know how much they will be used with the new windows installed.

Employees Like To Be Able To See Out

Employees do like to be able to look out of windows. We knew that when we designed this building and made it impossible for them to see out; however, we believed that their comfort was more important than being able to look out. It is impractical to provide the maximum degree of comfort for the employees working near the outer walls and still use conventional windows.

Since 1938 a satisfactory double glass has been developed, and we believe that double glazed transparent windows used with prismatic glass blocks make a very satisfactory solution. These windows will be cleaned on the outside by window cleaners working on staging suspended from the roof.

Twenty-six bays out of 142 are now completed and we look forward to doing the rest of the building in the near future.

Employees do like to be able to look out of windows, according to Detroit Edison's experience, but conventional windows make it impossible to provide the maximum comfort conditions for employees near them

Explains Manufacture of Camera Film

The sixth in a series of advertisements by the Armstrong Cork Co. stressing the importance of industrial insulation and air conditioning was devoted to how photographic film is made, and was prepared by the company's building materials division in cooperation with the National Association of Photographic Manufacturers.

The copy read in part:

"It's amazing what it takes to make some of the things we buy so casually. As an example, take photographic film—one of many products made by chemical processes. In film making, as in most chemical industries, heat and cold must be carefully controlled. That control requires the use of insulating materials.

"The making of photographic film starts with a compound manufactured from fibers of cotton and wood. This compound is dissolved to make a gummy liquid, which is filtered and stored. Then it flows evenly onto a giant wheel. On the wheel it is formed and dried into a continuous sheet of transparent plastic called film base. To make this base absolutely uniform, heat is controlled by surrounding the wheel and other equipment with magnesia insulation.

"Next, a thin coating of a liquid compound containing silver and gelatin—called 'emulsion'—must be applied to the base. The action of light striking this emulsion records what the camera sees.

"To make emulsion, silver bars are dissolved in nitric acid which forms silver nitrate. Distilled water and chemicals are added in total darkness. Then the emulsion is applied to the base. The rooms in this process must be entirely free of dust and held at exactly the right temperatures. This requires large amounts of conditioned air, cooled and kept cool along the way by corkboard on the ducts and on the roof. The pipes that carry the refrigerant are insulated with cork.

"After emulsion is applied, the film is dried and cut to fit your camera, then rolled on spools and boxed. To make sure that it arrives in perfect condition, the film is stored at 55 deg in a special room with corkboard on the floors, walls, and ceilings. And it is shipped in railway cars or trucks which are lined with corkboard or other insulations."

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WILLIAM B. PRIDE, plant engineering dept., Boeing Airplane Co., Seattle, has had a lot of experience in fuel economy and steam conservation work. He describes here tried and proved methods used by Boeing and a large group of Seattle's modern office buildings to simplify and assure fuel economy. Results obtained in the Boeing cafeteria building are cited as examples. Management as well as operating men will find this article interesting, informative. The method gives daily results

HERE'S HOW to Save HEATING STEAM

THIS ARTICLE was inspired by a question published in the January HPAC: "I wonder if it would be possible to say what the one most effective method of heating fuel conservation would be?"

This makes a most interesting topic for discussion. Fuel economy is a real contribution to the alleviation of existing fuel shortages; it also affects the pocketbook of every building and industrial plant owner. During these times of shortages in almost everything, every plant and building should stretch its fuel supplies in its own interest to insure its ability to continue production without costly shutdown periods. By concentrated and united effort, we can secure this insurance.

I will endeavor to show how it is being done by some building owners and plant operators.

Let's Make the Problem Clear

In setting up any fuel economy program, we must first have an objective. We must know what would be called economical operation. Consumption figures will differ slightly, depending upon:

1) Weather, which is largely determined by geographical location.

2) Method of heating, type and efficiency of heat generator.

3) Construction of the particular building or buildings under consideration, which will determine the heat losses.

4) Demands of the occupants, and/or processes requiring heat in some form, of subject buildings.

Since this article could otherwise easily develop into an entire volume or more, we are going to make some assumptions. Let us assume that the heat generator or source (whatever it may be) is operating efficiently, and that we are using steam (since our examples are worked out from steam consumption). Our fuel economy operation would commence with this steam after it has left the boiler, or, if we are using purchased central service steam, it

Every plant and building should stretch its fuel supplies in its own interest to insure its ability to continue production without costly shutdown periods, says the author. If fuel shortages caused difficulties this winter, now is the time to start planning fuel conservation measures for next winter. This is a picture of one of the Boeing boiler installations

would commence at the service valve where the steam enters the buildings.

This discussion will also be primarily concerned with fuel economy in relation to steam used for comfort heating, because comfort heating generally consumes the greater portion of steam used and that portion is the one we are constantly wondering about—whether we are operating efficiently or are overheating. The greater losses and wastes are generally in the comfort heating end. After an intelligent analysis, we realize how comparatively easy it is to effect (in most cases) considerable savings.

Metering Steam Consumption

In order to effect steam savings, we must know what our steam consumption is. The most accurate method of determining this is by metering our steam, either before it is condensed or by metering the condensation before it is returned to the boiler or dumped down the sewer. There are a number of different makes and types of steam meters, the installation of which can very rapidly be amortized from resultant fuel economy.

Prior to the installation of our meters, we must determine just what we desire to meter. Since we are working with comfort heating only, that is really what we are interested in metering (insofar as we are here concerned). This may mean we will have to make a few changes in existing steam piping, such as steam to hot water heaters or some particular process. It is advisable and recognized standard practice to have process steam piping separate from comfort steam heating, largely for economical reasons and due to the varied seasonal demands of the two.

In some cases, particularly on older installations and some wartime installations, these piping changes may cost more than we feel we can immediately justify. In this event, we will install additional metering, or make some calculations and deduct process steam consumption from comfort heating steam consumption. It is comparatively simple to make calculations for consumption of process steam, as considerable data have been published on steam consumption for heating water, process heating, humidity control, and drying processes; whether it be used in coils, tanks, or open jets, etc. Quite often, a good fuel economy program is a long-term operation, lasting two or three years before maximum savings can be realized and shown. In any case, we would still start our program immediately and use all or a portion of our known savings to accomplish further efficiency with piping changes, instrumentation, controls, etc.

The Boeing cafeteria seats about 2000. It is heated by forced air, with a gentle air movement from south to north (entrance doors are in south wall, kitchen is beyond the north wall) with some air being exhausted through overhead grilles in the north wall and the balance passing into the kitchen to maintain a negative pressure in the kitchen area and thereby eliminate odors in the dining room. Note the unique laminated Douglas fir arched beam construction

One scheme I have used with very good results, where there was considerable process steam piping connected with comfort steam piping, is as follows: We purchased two meters and several different sized orifices which gave us sufficient accurate range to enable us to meter almost any flow condition from zero to an estimated maximum. These two meters were installed temporarily (which generally meant for at least one month) on the various process lines, and thereby we readily determined our average, maximum, and minimum steam consumptions for these various steam consuming processes. Steam consumption on most processes is generally quite constant and once determined it does not vary enough to alter our calculations, unless the process is altered or eliminated, while in comfort heating the demands are many and varied. (Apart from the question under discussion, these steam meters can be used to very good advantage for studying steam loads under varied conditions, various problems encountered in trouble shooting, and for accurately determining the limitations of steam piping with regard to future loads and extensions.)

Now that we have our meters installed and can accurately determine the number of pounds of steam consumed for any given time we are ready to set up our steam economy program, which actually becomes part of the regular daily operating procedure and involves only a small additional amount of time—with such time paying very substantial dividends in the form of steam saved.

Comparing Heating Results

Let us use an old and recognized method for effecting and maintaining economical and efficient steam consumption, the degree-day method of comparing heating results. With it, we are able to compare the heating costs of one building with another, or determine approximate future consumption in some building or group of buildings. The term degree-day is a familiar one to those engaged in the heating field; as used in this article, we are concerned with the number of degree-days per day, which is the difference between 65 F and the daily mean outside temperature, when the latter is below 65 F.

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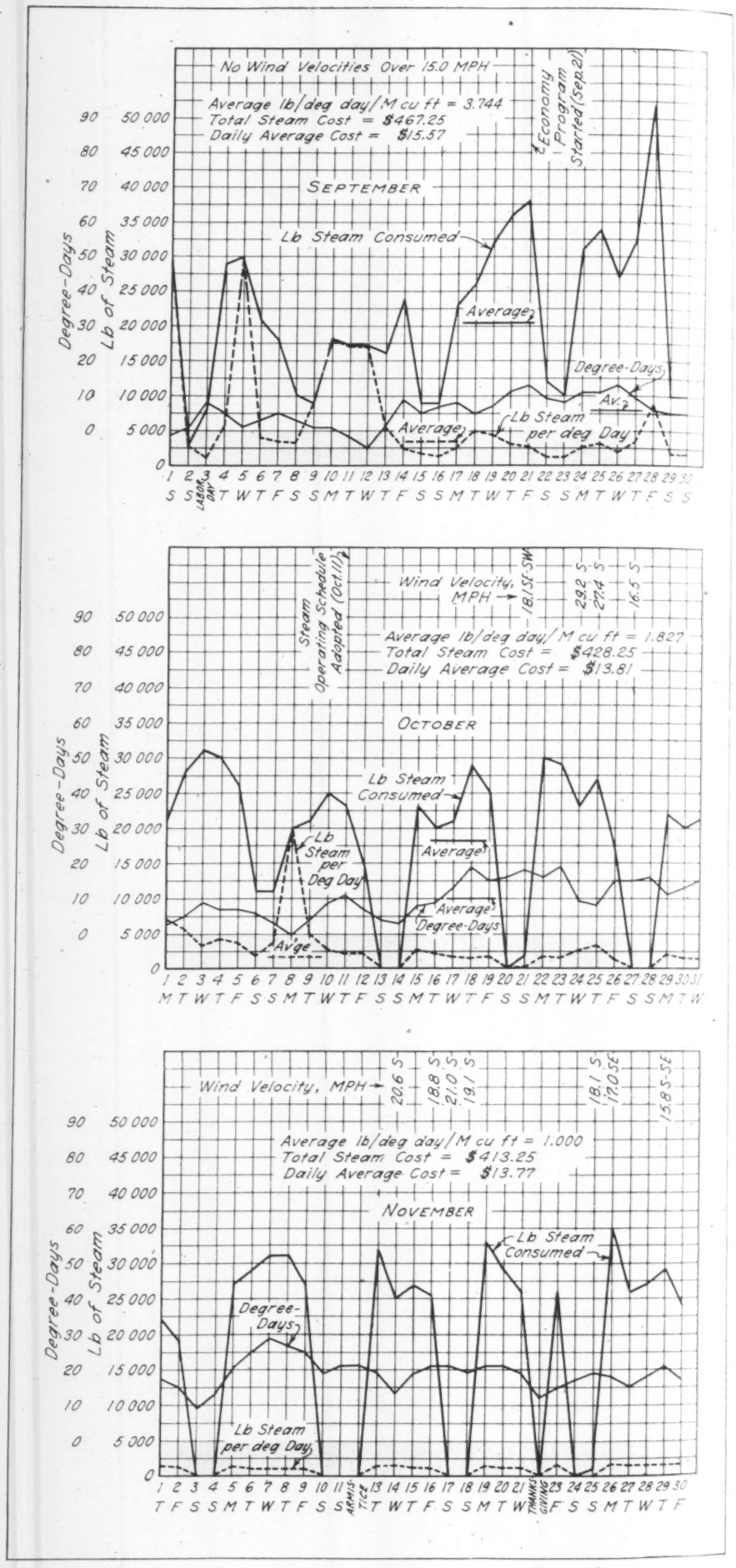
It is generally understood that when the outside temperature is 65 F or higher, no additional heat is necessary in a building—or we may say that when it is 65 F outside, it is 70 F or higher on the inside of a building of fair construction and average occupancy. Thus, assuming we have a daily mean outside temperature for a 24 hr period of 60 F, we say we have 5 degree-days for that day. Therefore, the number of degree-days for a given day equals (65 F — daily mean outside temperature for that day) times one day.

I determine the degree-days for the previous day from the daily records of the local United States Weather Bureau, and in the Monthly Meteorological Summary published by the Weather Bureau, in which are listed the daily degree-days for each day of the month, as well as the normal degree-days for that period, together with other degree-day data which are most interesting and helpful in making steam heating estimates and calculations.

By using this daily degree-day method for our calculations, we establish a consumption rate on a 24 hr basis. This 24 hr basis appears to be the most logical period of time to use regardless of the actual heating time or hours of building occupancy, as our steam consumption is definitely determined by the heat losses during this 24 hr period. This means that the steam meters should be read once every 24 hr, preferably at about the same time each day—either at the start of our heating-up period or at the end of our heating day. Some users work their consumption data down to pounds of steam consumed per degree-day



These three charts (for September, October, and November 1945) showing steam consumption for the Boeing cafeteria building illustrate to some extent the results made possible by use of the daily degree-day system. These particular charts do not show the lb per degree-day per M cu ft for each day, but the average figure for the month has been entered on each chart to be used in comparisons. The steam consumption figures shown cover gross consumption of this cafeteria, a sizeable portion of the steam being used for cooking, dishwashing, and water heating. The shaded area in each chart indicates zero degree-days, when no heating is necessary. Charts of this kind should be checked and analyzed every day to be of maximum value in conserving fuel. They are also of value when breaking in new personnel, as they give the new operators something to shoot at

per square foot of radiation. However, I have found that the best figure for comparison with other buildings, regardless of their location, is pounds of steam consumed per degree-day per 1000 cubic feet of space.

We have now arrived at a comparatively simple method of checking the operation of our comfort heating system. From our daily records, we find that during the month of December, for example, we consumed 2.4 lb of steam per degree-day per M cu ft of space. On checking various statistics compiled by the American Society of Heating and Ventilating Engineers, figures compiled by the National Association of Building Owners and Managers, and data readily available from local or nearby central service steam stations, we find that for our office building we should have consumed somewhere between 0.5 and 1.0 lb. Therefore, our operation is definitely not functioning with any degree of efficiency.

The "Hieronymus' Method" has, through empirical means, arrived at a standard for economical heating: 0.7 lb of steam consumed (for comfort heating) per degree-day per 1000 cu ft of building volume, for comfort heating in a commercial downtown building having a variety of tenants.

The results that have been reported by using the degree-day method of steam control are most gratifying. Many building owners and managers report savings as high as 50 percent. I have shown savings in excess of 30 percent on several jobs.

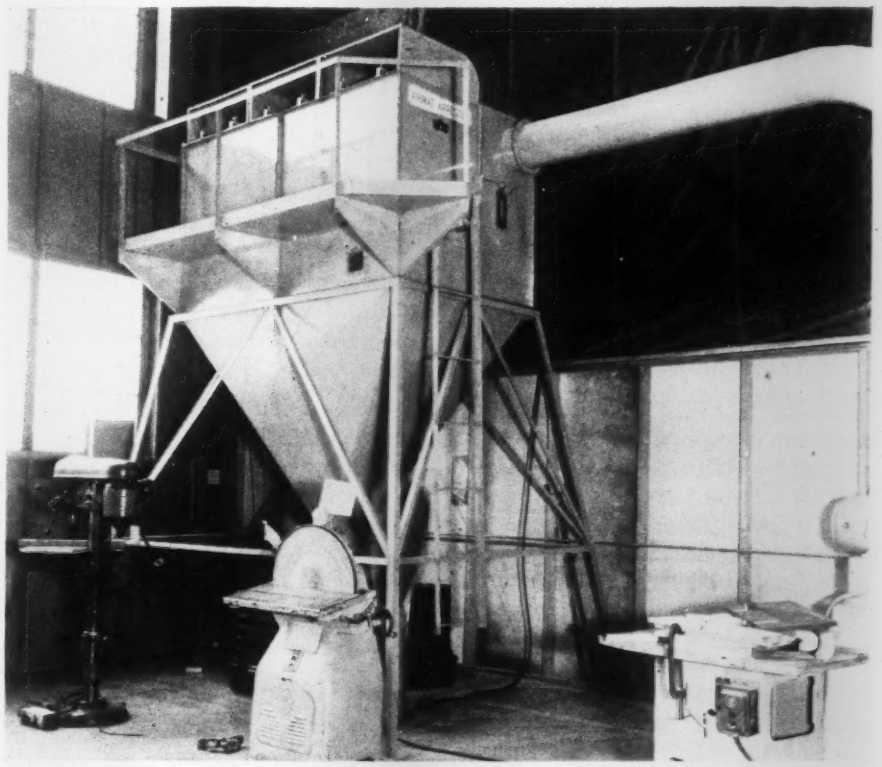
The Answer at a Glance

It is remarkable that the financial benefits which industry would realize by the prevention of heat waste through incorporating the degree-day system have not received greater recognition. Much research expense and large capital expenditures have gone into the study and operation of steam generating plants in order to reach peak efficiency. In many cases, as great or greater savings can be realized (generally with a minimum expenditure) in the field of economical steam usage.

Top management is primarily concerned with the final dollars and cents relation to steam savings. In the daily degree-day curves, it readily finds these answers. It can be determined, at a glance, all that management wishes to know regarding the comparable efficiency of the operation, as well as the efficiency of the operating and maintenance staff, without being concerned with any of the numerous details of the operation.

The operating staff finds, in the daily degree-day method of record-keeping, a simplified system whereby daily progress can be analyzed and peak efficiency maintained at all times without voluminous records, charts, and calculations.

There are many ways of applying the degree-day records and curves, and experience will determine which method best meets the needs of the individual plant. The advantage of keeping daily records is readily apparent, for the operating personnel soon realize that their control and operating methods *today* determine what will be plotted on the curve *tomorrow* (that is, with a few noted exceptions, in which case the records are still most valuable, as they clearly expose something unusual by the resultant hump or dip in the curve and thus the operator can take immediate steps to correct the situation, which may be leakage of valves; leaking steam traps; a coil, pipe, or piece of equipment that has sprung a leak; or neglect of control of heating.)



This picture shows a recent installation in one of the smaller Boeing shops. This is utilization of what would normally be exhausted heated air. Sawdust is deposited in the hopper due to the large expansion chamber and the consequent low air velocities. Air is passed through filter media and out of the three visible openings on the top of the unit. The filter sections were purchased units, the system and hopper being of Boeing design. Note the convenient access ladder and catwalk for filter inspection and servicing. The draft gage is visible, almost directly below the inlet pipe. This determines the inches of water gage resistance of the filter media—with new media it reads about 0.8 in. and increases as the media are loaded. There is a manual shakedown which is used once every 24 hr to vibrate the media and thereby remove a large portion of the fine sawdust

HOUSING CONSTRUCTION BREAKS ALL RECORDS

The building industry broke all previous records by putting 750,000 single family houses under construction in 1947, according to an analysis of government construction statistics prepared by the Construction Industry Information Committee. In addition, 105,000 multiple housing units were put under construction in 1947, a 30 per cent increase over the number started in 1946, according to the committee.

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Issues Final Report on Study of GRAPHITIZATION OF PIPING

THIS CONSTITUTES the seventh and concluding report on the Fundamental Investigation of Graphitization of Piping. Six previous progress reports have been distributed in mimeograph form to those interested, and published in the October 1943, April 1944, October 1944, July 1945, February 1946, and March 1947 issues of the Edison Electric Institute's Bulletin.

The sixth report summarized the work at the Battelle Memorial Institute, and indicated certain specific items which seemed to warrant further investigation in a limited extension of the research project at Battelle. The present report is primarily concerned with the results obtained at Battelle since March 1947, involving: (1) continued tests at 1125 F of previously tested materials which had indicated good resistance to graphitization; (2) further effort to evaluate the influence of elastic stress and plastic deformation on graphite formation.

Continued Graphitization Tests

A summary of the results of further graphitization tests at Battelle on a selected group of graphitization resistant steels is as follows; all of the samples were bead welded or from a welded joint:

Plain-carbon, low-aluminum: No graphite after 8500 hr at 1125 F either as welded, or as-welded and post-weld stress relieved at 1425 F.

Carbon-molybdenum, low-aluminum, Steel G-18: Trace of graphite, 15,200 hr at 1125 F. No measurable increase over previous test at 11,700 hr.

Carbon-molybdenum, low-aluminum, Steel G-19: Appreciable random graphite after 8500 hr at 1125 F. No graphite found on previous test of 5000 hr at 1125 F.

Carbon-molybdenum, silicon deoxidized: No graphite after 15,200 hr at 1125 F.

Carbon-molybdenum, titanium deoxidized: No graphite, 1700 hr at 1025 F, plus 8500 hr at 1125 F.

Chromium-molybdenum: Both high and low-aluminum deoxidized, ½ to 2½ percent chromium, ½ to 1 percent molybdenum. No graphite, 7500 to 8500 hr at 1125 F.

Molybdenum-vanadium: No graphite, 7500 hr at 1125 F.

The additional data summarized herein as well as that of other investigators[1, 2] confirm the previously expressed conclusions that chromium-molybdenum steels containing more than ½ percent chromium possess a high order of resistance to graphite formation for service temperatures of 1000 F or better. Apparently aluminum deoxidation may be used in manufacturing the steel if it contains more than ½ percent chromium without impairing its graphitization resistance.

The data further suggest that other compositions and types of low-alloy ferritic steel may also possess good resistance to graphite formation. The cast molybdenum-vanadium steel containing 1.15 percent molybdenum and 0.23 percent vanadium showed no graphite. Another laboratory[3], however, found graphite in an induction-melted forged 1½ percent molybdenum—0.16 percent vanadium steel after 10,000 hr at 1050 F. No aluminum was used in deoxidizing this steel. Still another laboratory[2] found graphite in aluminum-deoxidized cast molybdenum-vanadium steels containing about ½ percent molybdenum and about 0.15 percent vanadium after 20,000 hr at 1025 F.

Apparently the addition of vanadium alone to the extent of about 0.15 percent to an aluminum-deoxidized steel is in itself not sufficient to insure carbide stability, whereas a sample containing 0.23 percent vanadium, and made without aluminum deoxidation, is resistant to graphitization.

Graphitization Resistance of Steels

The exact effect of vanadium, manganese, and silicon on graphitization resistance of steels is not too well understood. Vanadium seems to be an inhibitor of graphite formation under certain conditions, but the data are insufficient to rate its effectiveness. Perhaps some minimum amount in relation to the carbon content must be present. There is some evidence that manganese may be an important factor in cast steels as both the molybdenum-vanadium, and the plain carbon steel which possessed good resistance to graphitization, contained well over 1 percent manganese. Finally, the role of silicon is much in doubt. The virtue of silicon killing as compared to aluminum deoxidation may result from the difference in effect that these elements exert as deoxidizers. Several investigators have reported that low-carbon rimmed (partially deoxidized) steel possesses remarkable resistance to graphitization at 900 F. Neither spectrographic nor chemical analyses offered any clue as to why one low-aluminum deoxidized carbon-molybdenum steel (G-18) showed only a trace of graphite after 15,200 hr at 1125 F, whereas the other (G-19) showed appreciable random graphitization after 8500 hr at the same temperature. Further investigation of the effect of deoxidizers might be worthwhile.

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[1] A Study of the Properties of 0.5 Percent Chromium—0.5 Percent Molybdenum Pipe Steel, by R. C. Fitzgerald, A. B. Wilder, G. V. Smith, and A. E. White. Presented at the annual meeting of the American Society of Mechanical Engineers, December 5, 1947.

[2] The Structural Stability of Several Cast Low Alloy Steels at Elevated Temperatures, by V. T. Malcolm and S. Low. Presented at the ASME annual meeting, December 5, 1947.

[3] Graphitization of Steel at Elevated Temperatures, by A. B. Wilder and J. D. Tyson, ASME preprint No. 14, 1947.

While it is possible that a molybdenum-vanadium combination, or a titanium or manganese steel, may readily meet service requirements, considerable further investigation would seem necessary firmly to establish such compositions. Chromium-molybdenum steels, on the other hand, are without question strongly resistant to graphite formation.

The data secured during the last test period seem to lend support to the theory that there may be an incubation period in the graphitization phenomenon. This would assume that all the common ferritic carbides are unstable, but for an idealized steel, the incubation period is so long as to indicate permanent stability, or at least stability for the useful life of the material. Present experience has been insufficient to determine whether or not the very resistant steels have incubation periods. If the material is stable over its useful life, whether or not it has an incubation period probably has little practical significance.

Specimens Stressed in Tension

As stated in the sixth progress report, previous efforts at Battelle to evaluate the influence of elastic stress and plastic deformation were not satisfactory, although cases were reported in the field where graphitization seemed clearly influenced by a deformation phenomenon. Further tests were undertaken in which deformation was obtained by stressing in tension using two types of tensile specimens and three types of steel. Results again were negative, however, as no correlation was obtained in these tests between graphite formation and plastic deformation.

Conclusion

The original and both supplementary programs at Battelle Memorial Institute have now been completed. It is now deemed possible, with the aid of these findings and those of independent investigators made available through ASME papers[4], and otherwise, to give reasonably definite answers to a number of the more important questions regarding graphite formation, many of which have been fully covered in previous progress reports.

Much remains to be done before a complete answer can be made available as to the mechanism of graphitization and the specific influence of the many contributing factors affecting graphite formation. As stated in the previous progress report, however, the problem now seems well enough understood, and the work has advanced sufficiently far to warrant leaving further research work on present and new materials to the research laboratories of steel mills, valve manufacturers, piping fabricators, and others. It seems prudent that operating companies continue to sample existing welded joints in susceptible materials as frequently as is deemed necessary to determine the presence and progress of graphite formation.

In concluding its work, the committee wishes to acknowledge with thanks the contributions of all those who assisted in this program.

[4] One or more sessions on graphitization were held during the annual meetings of the American Society of Mechanical Engineers in each of the years 1943, 1944, 1945, 1946, and 1947. Reprints of the 1943, 1944, 1945, and 1946 groups of papers have been distributed in bulletin form, as well as printed in the Transactions of the ASME.

FOLLOWING FAILURE in 1943 of a large carbon-molybdenum pipe carrying steam at 935 F temperature and 1250 psi pressure at a central station power plant, which failure was attributed to graphitization of the metal, a fundamental investigation of graphitization of piping was inaugurated and conducted by a joint subcommittee of the Edison Electric Institute and the Associated Edison Illuminating Companies (L. E. Hankison, T. E. Purcell, and Alex D. Bailey, chairman). This progress report No. 7, recently issued, constitutes the concluding report of the investigation. While much remains to be done before the mechanism of graphitization and the specific influence of the many factors affecting graphite formation can be completely answered, further research work on present and new materials can be left to the research laboratories of steel mills, valve manufacturers, piping fabricators, and others, says the EEI-AEIC committee

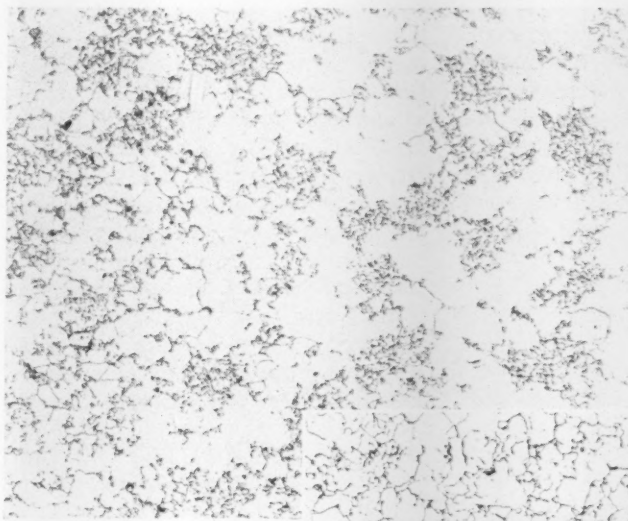

Fig. 1 — Photomicrograph (250 times) of low temperature edge of weld heat affected zone of a high aluminum killed, chromium-molybdenum steel (0.50 percent Cr), bead welded and treated 5000 hr at 1025 F. No graphite was found. This illustrates effectiveness of chromium in increasing graphitization resistance and in counteracting deleterious affect of aluminum

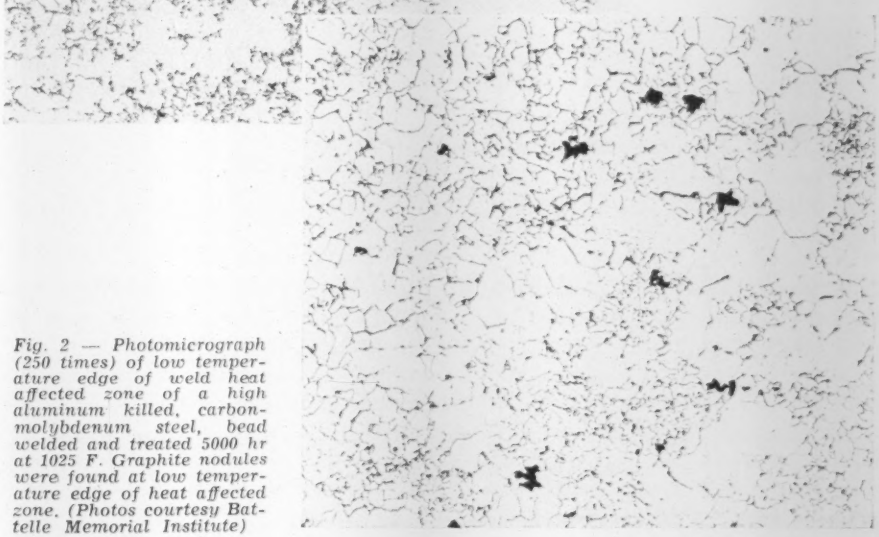

Fig. 2 — Photomicrograph (250 times) of low temperature edge of weld heat affected zone of a high aluminum killed, carbon-molybdenum steel, bead welded and treated 5000 hr at 1025 F. Graphite nodules were found at low temperature edge of heat affected zone. (Photos courtesy Battelle Memorial Institute)

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ALUMINUM PIPING

How to Use It

C. B. McLAUGHLIN, head of the engineering service division, Tube Turns, Inc., follows up his preceding article on the importance, the properties, and the advantages of aluminum and aluminum alloys for piping with information on the code requirements for piping design, fabricating techniques, and the various piping components which are available. Pointing out the lack of detailed specifications in the various codes, he lists recommended allowable working pressures for process piping except where specifically covered in codes

ALUMINUM AND its alloys have been generally available since 1920 but it is only recently that their many merits have been widely recognized and utilized in piping work. Advantages of these alloys include good strength characteristics, light weight, good thermal conductivity, resistance to corrosion, passivity when in contact with numerous corrodents, and the absence of sparking characteristics.

Various Alloys Now Available for Many Uses

Aluminum and aluminum pipe and wrought welding fittings are available in the form of commercially pure aluminum, designated 2S, and alloys respectively designated 3S, 61S and R361, 63S and "Alclad" 3S. For forged flanges an alloy designated 53S is employed. Cast valves are generally available in the alloy designated 43S. Cast fittings and flanges are available in the alloy B214. Alloy 3S pipe is also available clad with 72S (commercially pure aluminum alloyed with 1 percent zinc) and designated as "Alclad" 3S. The chemical composition of these materials is given in Table 2. Table 3 gives their physical properties.

The Charpy impact strength of wrought aluminum and its alloys is of the order of 10 ft lb at room temperature. This is substantially lower than carbon steel but is adequate for piping service. In addition, the toughness of these wrought aluminum materials is not substantially affected by low temperatures down to —320 F. Hence they may be safely used under subzero conditions. Cast aluminum alloys, on the other hand, are quite notch sensitive and have a materially lower impact strength.

When piping systems are subjected to unusual shock conditions, it would seem that care should be exercised in the use of the high strength aluminum alloys until further information is available.

Aluminum Piping Not Covered in Codes

There is a need for additional data on the as-welded properties of the higher strength aluminum alloys. Wrought aluminum and its alloys offer a wide range of physical properties which are secured by either cold drawing or heat treatment, or both. When such high strength materials are welded, the question arises as to how the physical properties of the heat affected zone, a width of one to five times the wall thickness, have been altered by the welding operation. This then raises the question regarding the basis for determining the pressure containing capacity of the pipe, i.e., can it be based on the work hardened or heat treated strength of the pipe proper, the as-welded physical properties, or the physical properties in the annealed state. Intensive investigations are under way to determine the answers to this complex problem.

Thus far, aluminum and aluminum alloy pipe have not been recognized in safety codes such as the Boiler Construction Code of the American Society of Mechanical Engineers and the American Standard Code for Pressure Piping issued by the American Standards Association, as indicated by the failure to include material specifications and allowable working stresses for pipe made of these materials. However, it is understood that the code making bodies have these piping materials under consideration and will soon publish allowable stresses. The ASME boiler code, section VIII on unfired pressure vessels, does provide allowable stresses for types 2S

Table 1—Relative Cost of Piping Materials*

Lap Welded Carbon Steel—ASTM A120	1
Seamless Carbon Steel—ASTM 106 Gr. A.	1
Wrought Iron—ASTM A72	2
Aluminum Type 3S	2
Aluminum Type 63S	2
Aluminum Type 61S and R361	2.25
Aluminum type 2S	2.5
5% Chrome Molybdenum ASTM A158 Gr. P5a	4
Copper ASTM B42	7.5
Red Brass ASTM B43	7.5
Silicon Bronze	8
Stainless Steel Type 304 ASTM A213 TP304	13
Stainless Steel Type 347 ASTM A213 TP347	16
Stainless Steel Type 316 ASTM A213 TP316	21

*Based on price per 100 ft of 6 in. standard weight pipe. Using carbon steel as 1, the others are priced on that basis.

Table 2—Chemical Composition of Aluminum and Aluminum Alloys for Piping Components

Item	Type	Form	ASTM Std.	Grade	Content in Percent: Aluminum	Silicon	Iron	Magnesium	Copper	Manganese	Zinc	Titanium	Chromium
1	2S	W	B178	A2	* (1)	Silicon plus Iron, 1.0 max							
2	3S	W	B210	M1	*	0.60 max	0.70 max		0.20 max	1.0-1.5	0.10 max		
3	43S	C	B26	S1	*	4.5-6.0	0.8 max	0.05 max	0.1 max	0.3 max	0.3 max	0.2 max	
4	53S	W			* (2)	0.7		1.3					0.25
5	61S, R361	W	B210	GS21	*	0.4-0.8	0.70 max	0.8-1.2	0.15-0.40	0.15 max	0.20 max	0.15 max	0.15-0.35
6	63S	W			* (2)	0.4		0.70					
7	B214	C			* (2)	1.8		3.8					

Note: (1)-Total of all elements, except aluminum, 1.0 percent maximum. (2)-Nominal composition. *-Remainder. W=Wrought. C=Cast.

and 3S sheet and plate for temperatures up to 400 F. From these and from the general principles underlying the established allowable working stresses by the code making bodies, it is possible to arrive at suitable design stresses for aluminum piping. These principles are as follows:

Allowable working stresses for piping falling under the jurisdiction of section I (power boilers) of the ASME boiler code, section 1 (power piping) and section 4 (district heating piping) of the ASA code for pressure piping are either 1/5 of the ultimate strength or 80 percent of the stress required to produce 1 percent creep in 100,000 hr (both values being determined at the actual operating temperature). The lower value of the two is the allowable working stress. For oil refinery piping (section 3 of the code for pressure piping), the allowable working stress is ¼ of the ultimate tensile strength, 60 percent of the yield strength, or the stress required to produce 1 percent creep in 100,000 hr, all determined at the operating temperature, the lowest value being selected. Chemical process piping in other than oil refineries is not specifically covered by any of the safety codes. In view of the similarity of the hazards involved, it would appear that the design of chemical process piping should follow the principles established in the oil piping section of the pressure piping code.

Chapter 3 of section 6 of the code for pressure piping treats of expansion and flexibility under the general heading of fabrication details. This chapter gives rules for determining the allowable stress range for the combined stress due to bending and internal pressure which should be adhered to in designing aluminum piping systems. The rules given in paragraph 620(g) and (h) in particular are worth quoting:

"(g) Where a piping system is subjected to the occasional temperature changes and to combinations of constant stress and minor cyclic variable stresses associated with the normal operation of the plant, the combined stresses due to bending and pressure shall not exceed three-fourths the sum (of the allowable working stress) for the piping material at atmospheric temperature and (the allowable working stress) at the nominal operating temperature, but in no case shall the combined stress due to bending and pressure exceed 40 percent of the specified tensile strength of the pipe material at room temperature.

The longitudinal pressure stress shall be determined by dividing the end force due to internal pressure,

$$F = \frac{p\pi d^2}{4}$$

by the cross-sectional area of the pipe wall,

$$A = \frac{\pi}{4}(D^2 - d^2)$$

in which P = internal pressure, pounds per square inch; d = nominal outside diameter of the pipe minus two times the nominal wall thickness, inches; and D = nominal outside diameter of pipe, inches.

(h) Where a piping system is subject to temperature changes of a definitely cyclic nature or to severe vibration that may result in failure by fatigue, the limit of the safe

Table 3—Physical Properties of Aluminum Alloys for Piping Components

Type	ASTM Spec.	Spec. Grade	Covers-	Tensile Strength Minimum psi	Yield Strength Minimum psi	Elongation in 2 in. Minimum Percent
ASTM Specifications						
Annealed						
2S	B178	A2	Plate	11,000		28
3S	B210	M1	Tubing			
3S	B126	M1	Plate	14,000		18
61S, R361	B210	GS21	Tubing			
61S, R361	B209	GS21	Plate			18
214	B26	G1	Castings	22,000		6
Cold Worked or Heat Treated						
2S-½H	B209	A2	Plate	16,000		6
3S-½H	B209	M1	Plate	19,500		7
61ST	B210	GS21	Tubing	42,000	35,000	10
Representative Values as Given by the Aluminum Producers						
Typical Minimum Values in Annealed Condition						
2S0				11,000	4,000	45
3S0				14,000	5,000	40
53S0				15,000	5,000	30
61S0				16,000	5,000	30
63S0				14,000	5,000	30
"Alclad"3S0				14,000	5,000	40
Typical Values in Cold Worked and/or Heat Treated						
2S½H or H14				17,000	14,000	20
3S½H or H14				21,000	18,000	16
53ST or T6				39,000	33,000	20
61ST or T6				45,000	39,000	17
63ST or T6				35,000	30,000	12
			Modulus of elasticity		10,000,000	
			Modulus of rigidity		3,850,000	
			Poisson's ratio		0.33	

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Table 4—Allowable Working Pressures for Annealed Aluminum Type 3S Pipe and Wrought Seamless Butt Welding Fittings

Nominal Pipe Size In.	Weight or Sch. No.	Wall Thickness In.	For Temperatures Not to Exceed- 150 F	250 F	300 F	350 F	400 F
¾	S-40	0.113	660	570	494	424	377
	X-80	0.154	900	770	680	580	520
1	S-40	0.133	620	540	465	398	354
	X-80	0.179	840	720	630	540	476
1¼	S-40	0.140	520	443	387	332	295
	X-80	0.191	710	610	530	453	403
1½	S-40	0.145	467	401	350	300	267
	X 80	0.200	650	560	484	414	368
2	S-40	0.154	397	340	298	255	227
	X-80	0.218	570	482	422	361	321
2½	S-40	0.203	432	371	324	278	247
	X-80	0.276	590	510	441	378	336
3	S-40	0.216	378	324	284	243	216
	X-80	0.300	530	450	394	338	300
3½	S-40	0.226	346	297	260	222	198
	X-80	0.318	487	417	365	313	278
4	S-40	0.237	322	276	242	207	184
	X-80	0.337	459	393	344	295	262
5	S-40	0.258	284	243	213	183	162
	X-80	0.375	413	354	310	265	236
6	S-40	0.280	259	222	194	166	148
	X-80	0.432	399	342	300	257	228
8	S-40	0.322	229	196	171	147	131
	X-80	0.500	355	304	266	228	203
10	S-40	0.365	208	178	156	134	119
	X	0.500	285	244	214	183	163
12	S	0.375	180	154	135	116	103
	X	0.500	240	206	180	154	137
14	S	0.375	164	141	123	105	94
	X	0.500	219	188	164	141	125
16	S	0.375	144	123	108	92	82
	X	0.500	191	164	144	123	109

Note: S=Standard. X=Extra Strong. Numbers are Schedule Numbers.

(1)—The above tabular values are rounded off to the next higher unit of 10 for pressures 500 psi and higher. Interpolation is permissible for intermediate temperatures.

(2)—The allowable pressures were calculated by the formula given in the American Standard Code for Pressure Piping, ASA B31.1-1942 Section 3, paragraph 325(a), as follows:

$$P = \frac{2S(t_m - c)}{D}$$

where P=allowable pressure in psig. S=allowable working stress in psi. D=outside diameter in inches. t_m=minimum thickness in inches or 22½ percent less than the nominal thickness shown in the table for wrought iron, and 12½ percent less for aluminum. c=allowance in inches for corrosion and/or mechanical strength, =0.05 in. for all pipe sizes for wrought iron, =0 for aluminum (nonferrous).

(3)—The allowable working stresses for aluminum correspond to the allowable stresses given for the annealed grade of specification SB 126 in the ASME Boiler Construction Code, 1946 Ed. section VIII, Table U-3, corrected from a safety factor of 5 to one of 4 in conformance with code practice in establishing stresses in the oil piping section.

(4)—Plant Process Piping: It is recommended that the allowable working pressures listed above be used also for process piping in plants other than oil refineries (such as chemical industries) except where such piping is expressly covered in the ASME Boiler Construction Code or other sections of the American Standard Code for Pressure Piping.

combined stress permitted in paragraph (g) shall be divided by 2."

As indicated in the foregoing, it is questionable at present whether it is permissible or desirable, in the case of welded aluminum piping systems, to determine the wall thickness of the pipe on the basis of its cold worked or heat treated strength or on the basis of its annealed strength, since the effect of welding is to anneal the pipe for a distance of one to five thicknesses from the centerline of the weld. Since aluminum piping is not treated by the codes, no direct guidance is available in them. However, an interpretation (known as Case 994) of section VIII of the boiler code has been made by the boiler code committee. According to this interpretation, when fabricating welded pressure vessels of *cold worked* type 3S plate, it is necessary to use the allowable working stresses established for *annealed* type 3S plate in table U3 of section VIII in designing the pressure vessel. Experiments are in progress to determine whether, in the case of seamless aluminum pipe, it is necessary to follow the ruling established in Case 994 or whether it is possible to take advantage of the higher physical properties of cold worked and heat-treated pipe in spite of the annealing effect of the welding operation. Until this work is completed it would appear necessary for the user to design welded aluminum piping on the basis of the annealed physical properties or to conduct bursting pressure tests on the type of material he wishes to employ.

Joint efficiencies established in the boiler code apply only to longitudinal joints. The efficiency of circumferential or girth welds is considered by the code to be 100 percent. Hence joint efficiencies need only to be taken into account in welded piping systems when the pipe is fabricated from plate by forming a cylinder therefrom and longitudinally welding it.

Allowable working pressures for annealed seamless type 3S pipe and butt welding fittings at temperatures up to and including 400 F are given in Table 4. These working pressures are based on the stress values given for annealed type 3S plate in table U-3 of section VIII of the boiler code multiplied by 1.25. The factor 1.25 has been used to convert the stresses from a factor of safety of five, used in section VIII, to a factor of safety of four, as used in the oil piping section of the code for pressure piping.

Cast screwed and flanged aluminum fittings are uniformly rated at 125 psi working pressure for service at room temperature. Pressure ratings at higher temperatures must be obtained from the individual manufacturer of the fittings.

Piping Components Listed

Tables 5, 6, and 7 list the various sizes in which aluminum and aluminum alloy pipe, tubing, fittings and flanges are regularly available. Pipe and tubing are either extruded or cold drawn. Speaking generally, the cold drawn product is closer to dimensions than the extruded type, although for most piping purposes both classifications should be satisfactory.

Cast flanged and threaded valves

are available in sizes from ⅛ to 30 in. in aluminum alloy 43S. These valves are available in 75, 100, 125, and 200 psi, with 18-8 stainless steel stem and wedge. Although the maximum temperature will depend on the service, these valves are recommended for service up to 350 F. For service above this temperature, stainless steel valves should be considered.

Many Techniques Used in Fabrication

Bending: Aluminum pipe and tubing can be formed cold or hot, following procedures similar to those employed when bending ferrous materials. In view of the wide varieties of tempers available, it will be wise to advise the supplier of the pipe of specific bending requirements.

Cutting: No difficulty should be experienced when the normal hack saw practice is followed. A cutting lubricant of kerosene and lardoil is quite satisfactory. When machine cutting, the best results can be obtained by using fine to medium feeds and comparatively high speeds.

Threading: When threading aluminum, a lubricant of zinc dust and vaseline, or heavy cup grease containing about 25 percent lubricating graphite should be used.

Welding: In introducing a section on welding, it should be pointed out that additional work on this phase is definitely indicated. More details are required regarding the exact welding procedure and joint design best suited for aluminum pipe welding. Welding aluminum plate and sheet is a relatively simple procedure when comparing it to pipe welding with its many additional problems. In what follows there will be presented the procedure presently recommended by the aluminum producers, together with the welding equipment manufacturers, for welding aluminum pipe.

Aluminum and its alloys are successfully manually welded by the employment of oxyhydrogen welding, oxyacetylene welding, metal arc welding, inert gas-shielded arc welding, carbon arc welding, and atomic hydrogen welding.

All aluminum alloys have these characteristics in common: their melting point is around 1100 F (as compared with 2700 F for steel), no color change takes place during the welding operation, a refractory oxide film forms during welding which must be dispersed, and the heat conductivity of the metal is high. To these facts must be added the problem of all-position welding usually encountered in piping installations.

In all aluminum welding, cleanliness is of prime importance. The oxides present on the edges to be welded and any dirt or grease should be removed before welding. Removal of oxide can be done mechanically with steel wool, a wire brush, or by a chemical etch.

The processes usually employed in welding aluminum piping consist of inert gas-shielded arc type welding using argon gas, oxyhydrogen welding, and oxyacetylene welding. The description of welding processes which follows is limited to these three since they are the only ones of commercial importance for pipe fabrication. The procedures given are those recommended by the aluminum producing companies. As indicated previously, investigations now under way are expected to develop more satisfactory procedures, specifically for pipe welding.

Inert Gas-Shielded Arc Welding Using Argon

The inert gas-shielded arc method appears to be the most suitable for the various requirements of pipe welding. An arc is struck between a tungsten electrode and the base metal, and an inert gas (argon) is used as a protective covering for the weld and filler metal. Alternating current welding is used with high frequency power superimposed on the welding circuit. In this method no flux is necessary. High purity (99.8 percent or better) welding grade argon must be used.

Where the thickness of the metal is 1/16 in. or more, the ends to be welded should be spaced from 1/16 to ⅛ in. apart. Square ends do not have to be separated for satisfactory results where the metal is less than 1/16 in. in thickness, but the standard 37½ deg bevel should be used on thicker material. Approximate machine settings for various metal thicknesses are shown in Table 8. The equipment required in addition to the standard a-c welding generator includes an argon tank, special hose, a special electrode holder, a source of cooling

Table 5 — Wrought Aluminum and Aluminum Alloy[1] Pipe, Tubing, and Butt Welding Fittings and Flanges[2]

	Size Range In.	Thickness Range
Seamless Pipe (IPS OD)		
Cold Drawn	⅛–12	Std. & E.H.
Extruded	½–12	Std. & E.H.
Seamless Tubing (Nom. OD)		
Cold Drawn	⅛–12	0.010 in.–0.500 in.
Extruded	¼–12	0.063 in.–1.500 in.
Seamless Butt Welding Fittings		
90 deg Ells, Long Radius	½–14	Std. & E.H.
45 deg Ells, Long Radius	½–14	Std. & E.H.
180 deg Returns, Long Radius	½–14	Std. & E.H.
90 deg Ells, Short Radius	1–16	Std.
90 deg Ells, Short Radius	1¼–16	E.H.
180 deg Returns, Short Radius	1–16	Std.
180 deg Returns, Short Radius	1¼–16	E.H.
Tees, Straight and Reducing[3]	½–8	Std
Tees, Straight and Reducing[3]	½–5	E.H.
Reducers, Concentric and Eccentric	½–10	Std. & E.H
Lap Joint Stubs	½–10	Std. & E.H.
Caps	1–24	Std. & E.H.
Crosses[3]	½–8	Std
Crosses[3]	½–5	E.H.
Welding Flanges		
Welding Neck	Available on Application	

Notes:

(1) — The pipe, tubing, and fittings listed in this table are regularly available in alloy 3S. Pipe and tubing are also regularly available in Type 2S, 61S, R361, and 63S in various hardnesses or temper. Fittings of these materials are also available on special order. Flanges are furnished only in Type 53S.

(2) — Fittings are regularly made to IPS dimensions. Fittings to match tubing dimensions are available on special order. Fittings grooved for special couplings are also available on special order.

(3) — Tees and crosses drawn from fusion welded pipe can be obtained in sizes up to 18 in. on special order.

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Table 6—Cast Aluminum Alloy[1] Screwed Fittings and Flanges, 125 psi[2]

	Size Range In.
90 deg Elbows	1/8-6
90 deg Elbows, Reducing	1/4-2
45 deg Elbows	1/8-5
90 deg Street Elbows	1/8-6
90 deg Street Elbows, Reducing	1/4-4
45 deg Street Elbows	1/8-2
180 deg Close Returns	3/8-4
180 deg Open Returns	3/8-4
Tees, Straight	1/8-6
Tees, Reducing	1/4-2
Y's, Straight	1/8-5
Crosses, Straight	1/8-4
Reducers	1/8-6
Plugs, Square Head	1/8-6
Bushings	1/8-6
Caps	1/8-6
Couplings (Std. and Extra Heavy)	1/8-6
Unions	1/4-2
Locknuts	1/8-4
Nipples[3]	1/8-4

Notes:
(1) The fittings listed are regularly available in Alloy B214. Fittings cast in other alloys may be obtained on special order.
(2) These fittings are air tested at 60 psig. They are rated at 125 psi working pressure at 150 F. For adjusted pressure-temperature ratings at higher temperatures, consult the manufacturers. These fittings meet U.S. Navy specification 45F11.
(3) These nipples are made from the wrought aluminum materials.

water, a high frequency stabilizer, and a regulator and flowmeter.

The welds being produced by this method are of excellent quality. The fact that no flux is necessary and the fact that all position welding is possible are worthwhile advantages.

Oxyhydrogen and Oxyacetylene Welding

One of the national pipe fabricators has expressed a preference for the oxyhydrogen welding method. In making a recent installation, all of the welding qualifications, including the back and face bends and elongation tests required by the ASME code, were met by this method.

The same comments on joint preparation made before also apply to gas welding.

In oxyhydrogen and oxyacetylene methods, aluminum flux is used on both the material to be welded and the rod. Complete removal of the flux is mandatory. This is done immediately after welding by washing, both the inside and outside, with hot water. This should be followed by immersion in, or flushing with, a 10 percent nitric-0.25 percent hydrofluoric acid solution for five minutes, followed in turn by a water rinse.

Preheating from 500 to 700 F is desirable on heavy sections. Temperature indicating equipment is preferable for control. A pine stick rubbed on the part will char at about 650 F. A carpenter's blue chalk mark will turn white in this range. Temperature indicating pencils which are made to indicate temperatures in increments of 50 F are probably the simplest, and most accurate means of checking the preheat temperature.

A neutral or slightly reducing flame is recommended. A neutral flame is indicated by a well defined blue cone near the torch tip. The best results will be gained from using the proper size tip, as indicated in the following tabulation.

Thickness In.	Tip Orifice Diameter In.
0.051	0.065
0.065	0.065
0.125	0.095
0.187	0.095
0.250	0.105
0.375	0.125

Usually two to four volumes of hydrogen are used to burn one volume of oxygen. Adjustment is a matter of experience.

Forehand welding is usually considered the best technique as it aids the preheating. The torch is held at a low angle on thin material and approaches the vertical on thicknesses 3/16 in. and heavier. In flat position welding, the operator uses a slight weaving motion, dipping his rod in the weld puddle periodically, then withdrawing it with a forward motion. In vertical position welding, the torch is given an up and down motion, and the operator stirs the weld metal with the rod at all times.

Research Work Now in Progress

The author's purpose in discussing this subject is to indicate the desirable characteristics of these alloys and to invite close analysis of what they can offer. The research committee of the Heating, Piping, and Air Conditioning Contractors National Association, in conjunction with the author's company and the aluminum producing companies, is carrying on a research program directed toward developing a simpler, more readily controllable procedure, and it is expected that considerable information will be available by next June. Other cooperative programs promise new and interesting developments in the near future.

Table 7—Cast Aluminum Alloy[1] Flanged Fittings and Flanges, 125 psi[2]

	Size Range In.
90 deg Elbows	1-8
90 deg Long Sweep Elbows	1-8
90 deg Side Outlet Elbows	1-8
45 deg Elbows	1-8
Tees	1-8
Tees, Single Sweep	1-8
Tees, Double Sweep	1-8
Tees, Side Outlet	1-8
Crosses	1-8
Laterals	1-8
Y's	1-8
Reducers	1-8
Flanges, Screwed	1-8
Flanges, Blind	1-8

Notes:
(1) The fittings listed are regularly available in Alloy B214. Fittings cast in other alloys may be obtained on special order.
(2) These fittings and flanges conform to the dimensions of 150 lb cast steel flanged fittings and flanges (See ASA Standard B16e). They are air tested at 60 psig and are rated at 125 psi working pressure at 150 F. For adjusted pressure-temperature ratings at higher temperatures, consult the manufacturers.

An index to Heating, Piping & Air Conditioning—and to the Journal Section of the American Society of Heating and Ventilating Engineers—for the year 1947, Vol. 19, Nos. 1-12, is available to subscribers without charge on request.

Table 8—Machine Settings for Inert Arc Welding Aluminum Alloys

Thickness In.	No. Weld Beads	Welding Current Amp	Argon Volume Cu Ft per Hr	Cup Opening Diameter Sixteenths	Filler Wire Diameter In.
0.051	1	70	12	6-7	1/8
0.065	1	80	14	7	1/8
0.080	1	90	14	7	5/32
0.100	1	120	15	7-8	5/32
0.125	1	140	15	7-8	5/32
0.250	2	220	20	8	3/16
0.375	2	300	24	8-10	3/16

MEETINGS & CONVENTIONS

The middle-of-the-year "convention season" is coming soon, so now is the time that those who plan to attend one or more of these affairs must make their transportation and hotel plans. It's usually a good idea to arrange for hotel reservations just as early as possible.

The 1948 Western Refrigeration Educational Exhibit and Conference—in conjunction with the second annual convention of the California Association of the Refrigeration Service Engineers Society, April 30, May 1 and 2, Palace hotel, San Francisco. This conference and exhibit are sponsored jointly by the California Association of Refrigeration Service Engineers and the Refrigeration Equipment Manufacturers Association, 1107 Clark Bldg., Pittsburgh 22, Pa.

American Foundrymen's Association, 222 W. Adams St., Chicago—1948 convention and exhibition, May 3 to 7, Philadelphia Convention hall to be the scene of the exhibition.

Second Engineering Progress Show, May 11 to 16, Franklin Hall, Franklin Institute of Pennsylvania, Philadelphia—sponsored by the junior members of the Engineers Club of Philadelphia and the Franklin Institute of the State of Pennsylvania.

National District Heating Association, 827 N. Euclid Ave., Pittsburgh 6, Pa.—39th annual meeting, May 18 to 21, Hotel Statler, St. Louis, Mo.

American Society of Refrigerating Engineers, 40 W. 40th St., New York City—35th annual spring meeting, May 31 to June 2, New Ocean House, Swampscott, Mass.

Heating, Piping, and Air Conditioning Contractors National Association, 1250 Avenue of the Americas, New York City—59th annual convention, June 1 to 5, Hotel William Penn, Pittsburgh.

Third Annual Home and Building Exposition, June 10 to 20, Pan-Pacific Auditorium, Los Angeles—the show is owned by the Los Angeles chamber of commerce and 14 major construction industry associations of southern California.

I-B-R Short Course in Heating, sponsored by the University of Illinois and the Institute of Boiler and Radiator Manufacturers. To be held at the university June 15 through 17, it is a three day short course for the study of hot water and steam heating systems. Address requests for information to H. C. Rountree, assistant director, Division University Extension, room 118A, Illini Hall, University of Illinois, Champaign, Ill.

Stoker Manufacturers Association, 307 N. Michigan Ave., Chicago 1—annual meeting, June 17-19, Greenbrier Hotel, White Sulphur Springs, W. Va.

American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York City—1948 semi-annual meeting, June 21 to 23, Mount Washington hotel, Bretton Woods, N. H.

American Society for Testing Materials, 1916 Race St., Philadelphia—annual meeting, Book-Cadillac hotel, Detroit, June 21-25.

National Warm Air Heating and Air Conditioning Association, 145 Public Sq., Cleveland—midyear convention, June 29-30, Edgewater Beach hotel, Chicago. Midyear convention of the National Heating Wholesalers Association, 2130 Keith Bldg., Cleveland 15, will be held at the Edgewater Beach on June 28.

National Catholic Building Convention and Exposition, Inc., 185 N. Wabash Ave., Chicago, Ill.—building convention and exposition, June 30, July 1 to 3, Stevens hotel, Chicago.

The 2nd International Store Modernization Show, July 6 to 10, Grand Central Palace, New York City. Invitations for admission can be obtained from exhibitors or from the Store Modernization Show, 40 E. 49th St., New York 17, N. Y.

The Third National Instrument Conference and Exhibit—sponsored by the Instrument Society of America, 1117 Wolfendale St., Pittsburgh 22, Pa. To be held September 13 to 17, Philadelphia Convention Hall.

American Gas Association, 420 Lexington Ave., New York City—1948 convention, the week of October 4, Atlantic City.

American Chemical Society, Chicago section, 1513 S. Wabash Ave., Chicago 5—Fifth National Chemical Exposition, October 12 through 16, Chicago Coliseum.

National Association of Housing Officials, 1313 E. 60th St., Chicago 37—annual meeting, October 13-16, Olympic hotel, Seattle.

American Welding Society, 39 W. 39th St., New York City—annual meeting, October 24-29, Bellevue-Stratford hotel, Philadelphia.

Pan-American Engineering Congress, to be held late in 1948 or in 1949, South America—further information to be released by the Engineers Joint Council Committee on International Relations, 29 W. 39th St., New York City.

Ninth International Heating, Ventilating, and Air Conditioning Exposition, January 24 to 28, 1949, International Amphitheatre, Chicago—under the auspices of the American Society of Heating and Ventilating Engineers.

Sixth All-Industry Refrigeration and Air Conditioning Exposition, the week of November 14, 1949, Atlantic City—sponsored by the Refrigeration Equipment Manufacturers Association.

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PRACTICAL PIPING PROBLEMS

Design Engineer Reports on Operating Experience

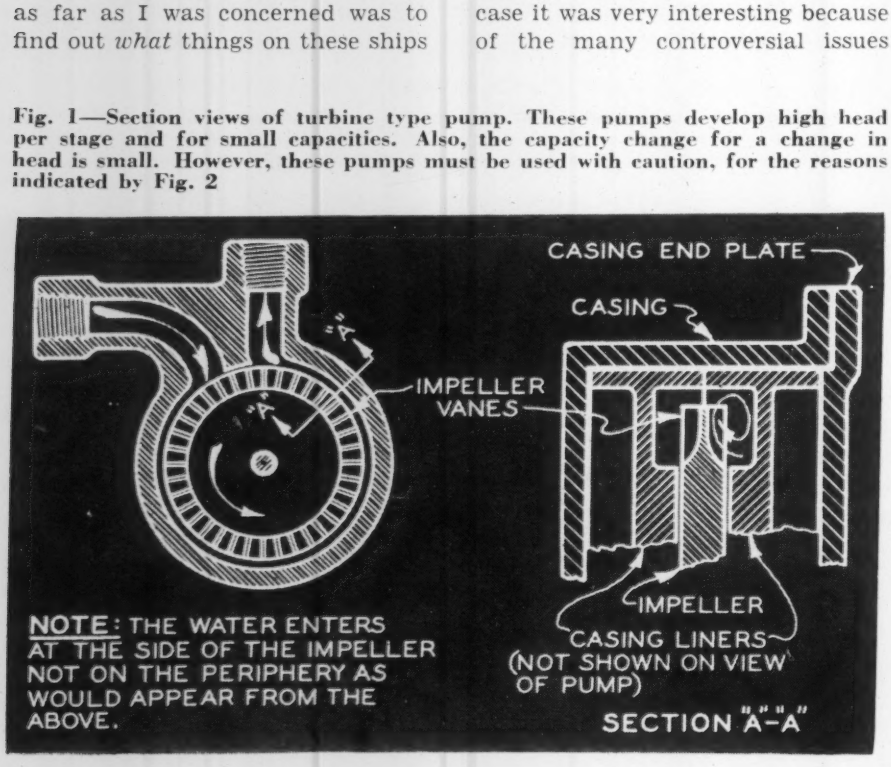
***JOHN H. CLARKE** wanted information on the problems with piping systems, pumps, valves, heaters, control, and other mechanical equipment faced by the operating man . . . how designs perform in actual service . . . how equipment is actually operated . . . when he (a marine design engineer by training and profession) shipped on a tanker as junior third assistant engineer. By the time his seagoing was completed (he's now a design engineer with the Standard Oil Company of Indiana) he got plenty of practical information on piping, pumping, heating, ventilating, and other subjects, much of which he summarizes in these articles. His observations apply not only to marine work but also to the equipment in plants and buildings*

OPERATING DIFFICULTIES and "incidents" described in my previous articles in HPAC about my life at sea aboard two turbo-electric tankers—one a 10,000 hp and the other a 6600 hp ship—may have caused some readers to wonder how the ships ever were able to sail, let alone limp back into port. In this regard, one should not lose sight of the fact that the crews of these ships were young and inexperienced; that the personnel turnover for each voyage from the United States and enroute was very high, resulting in poorer operation and maintenance; and that these ships were built with wartime materials and expediency.

The more efficient operation of the oldtime tanker fleets would in no way be comparable to the inexpert operation of the ships described in this and my preceding articles. Further, it should be kept in mind that the object of the trip as far as I was concerned was to find out *what* things on these ships were going wrong, *why* they were going wrong, and, insofar as possible, the extent to which the operating engineers, the design, and the equipment were responsible for these difficulties.

It is an invaluable opportunity for any engineer to be able to follow up on the success (or failure) of designs in which he has been actively engaged. In this particular case it was very interesting because of the many controversial issues which had come up in the design, construction, and operation of these particular ships. I was with the United States Maritime Commission at the time this turbo-electric design was originally proposed, and was one of a number of engineers then assigned the task of reviewing and recommending changes in the specifications. Several years later the acquaintance was renewed when it was my privilege to become assistant marine engineer of one of the wartime western shipyards which was primarily engaged in building these tankers.

Fig. 1—Section views of turbine type pump. These pumps develop high head per stage and for small capacities. Also, the capacity change for a change in head is small. However, these pumps must be used with caution, for the reasons indicated by Fig. 2


CASING END PLATE
CASING
IMPELLER VANES
IMPELLER
CASING LINERS (NOT SHOWN ON VIEW OF PUMP)
SECTION "A"-"A"
NOTE: THE WATER ENTERS AT THE SIDE OF THE IMPELLER NOT ON THE PERIPHERY AS WOULD APPEAR FROM THE ABOVE.

While we at the shipyard did not draw up the original design plans for these ships, we did redraw the plans to eliminate interferences, to suit the equipment and materials furnished us at the shipyard, and to take care of the many seemingly inevitable changes when a series of ships is built. Most of the latter are brought about by operating troubles; the whims of the various operators, real and fancied; and by the request for design improvements by the various organizations interested in the construction of the ships.

As would be expected with so many design organizations involved, there were a great many differences of opinion as to what design changes were necessary and as to

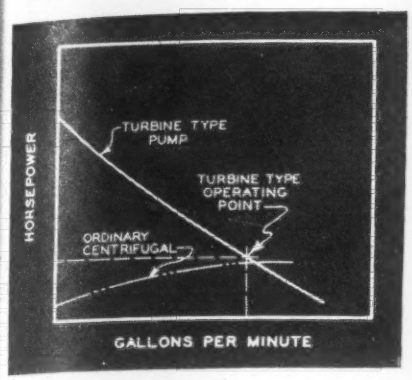


Fig. 2—Typical horsepower—capacity curves for "turbine" type and for ordinary centrifugal pumps. Note that the centrifugal pump has a *nonoverloading* horsepower curve whereas the turbine type curve is *overloading*. Because the shutoff horsepower for the turbine type pump may be two to nearly four times the design operating horsepower, the pumps and motors must be carefully selected

whether or not the reasons given by the operators for their requested changes were bona fide. Many times we found them to be in the realm of folklore. More often they had legitimate reasons for their difficulties. A number of these items have already been mentioned. Some of the more general problems will be covered in this summary.

Correct Installation of Turbine Type Pumps

One of the more interesting problems involved the use of the so-called turbine type pumps, as shown in Fig. 1. This pump is more correctly defined by the Hydraulic Institute as a peripheral type of centrifugal pump, and its feature is its ability to obtain high head per stage with small capacities. This high head is obtained because of the fact that the fluid enters the side of the impeller, is thrown outward, leaves and re-enters the impeller. Consequently there is a buildup of pressure all the way around the periphery of the impeller in the direction of rotation. This very effect, however, is responsible for two undesirable characteristics.

First, the sudden and dynamic buildup of pressure when the pump starts is similar to that of a positive displacement pump; consequently, it is often necessary to use some sort of gage snubber to avoid damage to the discharge pressure gages. This we learned to our sorrow when at the shipyard gage after gage on our atmospheric tank pumps was broken by the sudden high starting-up pressure. We were finally able to obtain gage snubbers, and our problem was corrected. On our similar pumps, the gages were also absorbing these heavy pressure surges but we had no actual gage damage. It is possible, however, that if the gages had been checked they would have been found to be out of calibration.

The second undesirable characteristic of these pumps is that they have a higher shutoff horsepower than the horsepower required under the normal design conditions. This is shown by Fig. 2. This shutoff horsepower may be from two to nearly four times the design conditions. Consequently, it is of the utmost importance that these pumps not be used in throttling service or where the discharge can be inadvertently shut off *unless a backpressure regulating valve is installed*, as in Fig. 3, in order to keep enough water moving so as to keep the motor from overloading.

Table 1—Capacities and Horsepowers of the Ship's Turbine Type Pumps

Pump	Gpm	Head, Psi	Motor Hp	Shutoff Hp (approx.)
Wash water†	20	60	2	7.4
Evaporator feed	20	30	1	2.
Drinking water†	6	60	1	2.
Refrig. circ.	15	22	½	1.2
Atmos. drain tank	10	40	1½ (later 2)	4.

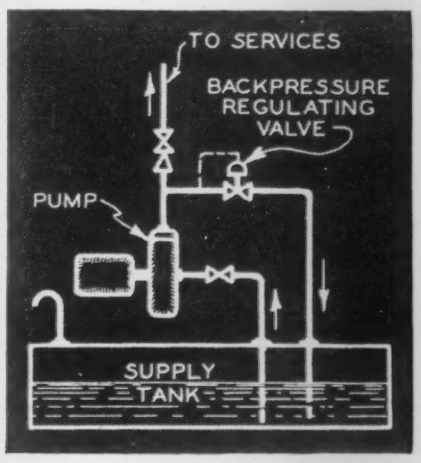
† Both wash water pumps and the forward drinking water pump had backpressure regulating valves to keep the water at constant pressure and to keep water circulating. These pumps were supposed to operate at 60 psi but the regulating valves had to be set at 50 psi to keep the motors from overloading.

It is equally important that the service conditions be carefully ascertained, because if the requirements are overestimated, this will mean that the pump will operate too far back on its curve and may still overload the motor. Note the figures given in Table 1 with respect to the motor and the pump shutoff horsepowers. We had backpressure regulating valves on our wash and drinking water pumps but a miscalculation was evidently made in the horsepower required. For both of these pumps, it was necessary to reset the regulating valve to 50 psi in lieu of the 60 psi originally specified; otherwise the motors would overload and trip out.

On the wash water pumps, the recirculating water went back to the suction line. At periods of low load (such as during the night) so little water would be used that the recirculating water would heat up to an undesirable degree. To minimize this effect, and also because the evaporator pump did not appear to have the necessary operating capacity and pressure required, we fed the evaporator from the wash water system. The drinking water return from the backpressure valve went back to the drinking water tank. Thus, overheating of the water and the pump was avoided. Recirculation for a pump should always be done in this manner where possible in order to avoid overheating, vapor binding, and possible damage to the pump.

The refrigeration condenser circulating pumps for these ships were never used to the best of my knowledge, and were never really needed on the ships. We could supply this condenser water from either the sanitary (flushing) pump or the salt water service (cooling water) pump, and standby service was provided from the fire main, permitting the use of either fire pump. But what made the turbine type refrigeration circulating pump useless was that there was no backpressure regulating valve on the pump discharge, the refrigeration condenser was oversized and often required only a trickle of water, and the condenser water regulating valve held down the pump capacity to the point where the motor would overload and trip.

Fig. 3—Diagram of backpressure regulating valve piping for maintaining constant flow and constant discharge pressure. Such a regulator should always be used with a turbine type pump (Fig. 1) where there is any possibility that the discharge from the pump might be shut off — such as during periods of low usage



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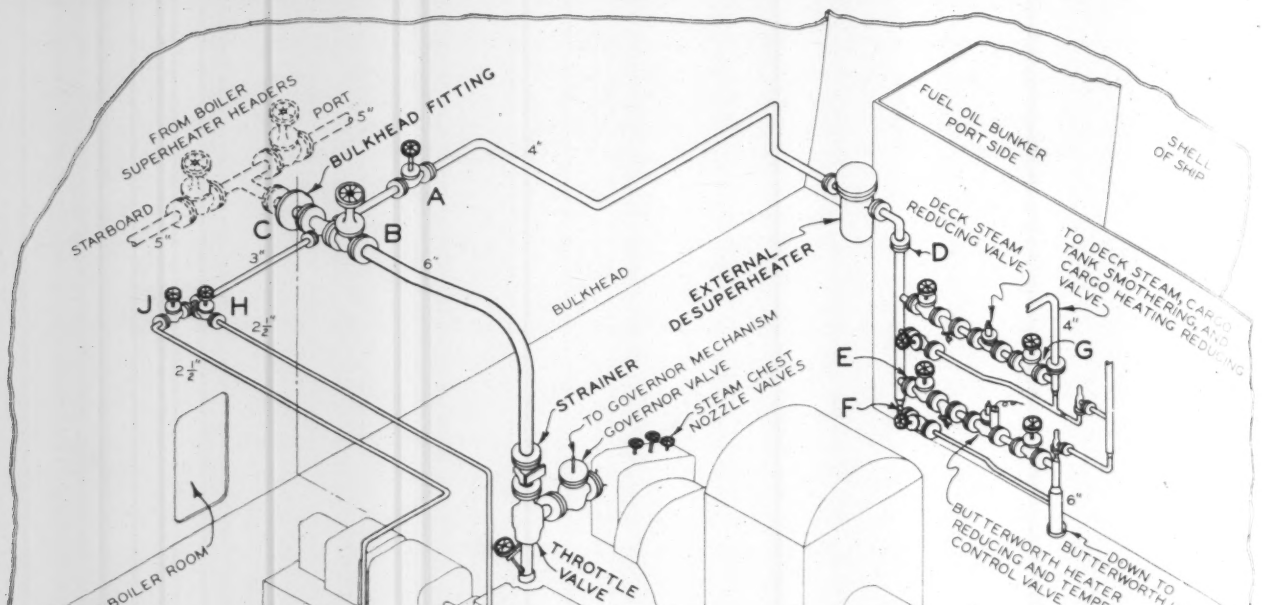

Fig. 4—Isometric of externally desuperheated auxiliary steam, and the main steam piping for the turbo-electric tanker described in this article. This drawing shows the points at which trouble was encountered with leaking valves and flanges, much of which was probably caused by the high stress conditions in the piping

At the shipyard we provided a recirculating line and a key operated valve. This helped some, but we still had trouble. It used so little water that every time the ship would go astern, the pump would get airbound and lose its prime. Whenever a ship goes astern, the propeller cavitates and considerably aerates the water near the ship, particularly near the stern, where this pump was located. In view of the above facts, it is no wonder that this pump was never used on the ship after the trials were completed. Had we been as smart as we should have been, we would have eliminated it.

Cross-Connecting Piping Services

An important item in any piping design is to be sure that the services are properly separated and cross-connected so as to provide for the best possible operation, and so as to allow for emergencies. The importance of this can well be illustrated by the compressed air and the desuperheated steam systems on these ships. All compressed air—whether for instruments or for ship's use, such as cleaning, painting or pneumatic tools—was taken from a single service main. At the shipyard, we improved the system somewhat by taking the service air and the instrument air off the air receiver directly, via separate mains, but the same "main" and "make-up" compressors served both systems through the air receiver.

The better and more conventional method would have been to provide a separate compressor for instruments, with a cross-over to the main service air system. Twice during the trips on the two ships heretofore mentioned, workmen or members of the crew nearly put the combustion control system out of order because, while using an air hose for cleaning around the boiler, they did not notice the considerable loss in air pressure.

In our steam piping, the trouble was of a slightly different nature. All of these ships had two auxiliary live steam services—the internally desuperheated, and the externally desuperheated. There were no cross-connections between the two systems. The first system served the fuel heating, feed heating, air ejectors, steaming out services, port generator, the aft deck winch, the steam cargo stripping pump, and the main and auxiliary feed pumps. The steam to the feed pumps was taken off at full boiler pressure.

The externally desuperheated system was taken off the main steam line, desuperheated in a cartridge type desuperheater, and then reduced in pressure for the forward deck steam, cargo tank cleaning, cargo heating, and cargo tank and forward stores spaces steam smothering (for fire fighting), as shown in Fig. 4. It was our belief at the shipyard that this system was not properly designed in that the frequently used, low capacity, forward deck services, and the cargo tank steam smothering system for fire fighting, should have been taken off the boiler internal desuperheater. This would have left the high capacity cargo tank cleaning and cargo heating systems on the external desuperheater, which would have been very advantageous. Deck steam could have been turned on and off with a single valve without the necessity of putting the large capacity (28,000 lb per hr) desuperheater into service for a small (2000 to 3000 lb per hr) load, and without turning on a separate reducing station.

Likewise, the cargo tank steam smothering system could have been turned on immediately by means of the master valve provided for the purpose, without the need to go

through the same time-consuming procedure as for turning on deck steam. Strictly speaking, the United States Coast Guard requires that the steam smothering system for fire fighting be ready for immediate operation with nothing more required to accomplish this than the opening of the one master valve mentioned above. All steam smothering valves at the tanks were required to be open at all times. Ours, incidentally, were never open for the duration of our six month trip.

The only disadvantages in separating the steam services as suggested above were that it would have been necessary to increase the size of the boiler drum internal desuperheating coils, and the capacity of the 150 psi reducing valve. Both of the above could have been done readily. Each boiler on these ships had a nominal internal desuperheater capacity of about 2100 lb per hr. Most of the Maritime Commission ships for long range design were provided with a minimum internal desuperheating capacity of at least 5000 lb per hr of steam per boiler. For fire fighting, the capacity of the internal desuperheaters can be greatly increased at the sacrifice of a lower initial pressure at the reducing valves, and a higher temperature. Neither would have been serious. The reducing valve problem could have been handled by providing a small and a large capacity valve in parallel, the latter coming into service on a specified drop in the service pressure.

Had the above factors been given proper consideration, the operation of these ships would have been much easier, maintenance would have been reduced, and the ship would have been much safer from a fire fighting standpoint. As it was, many of the operating companies solved the problem as best they could—at their own expense—by installing a crossover line from the normal 150 psi service (from the internal desuperheater) to the deck steam line at the reducing stations.

Use Guarding Valves on High Pressure Services

There are many other small items that come to mind on a trip of this sort. In previous issues, emphasis has been placed on the need to check all valves for proper bolting clearance, and to be sure that some positive means is provided to keep the handwheels from falling off. It was also pointed out how important it is to be sure that the systems are properly sectionalized so as to permit all the repairs possible without the necessity of shutting down the plant.

Along this same line, I have become a firm believer in the use of guarding valves for high pressure steam services, particularly for drain, vent, and blowdown lines which are frequently used. Our marine engineer at the shipyard was a fanatic on the subject, and rightly so. I have on several occasions seen emergencies arise where a guarding valve permitted the drain (or piping) to be shut off while the valve causing the trouble was either ground in or else cleaned of the scale which did not permit it to close. With few exceptions, we did not have guarding valves on the two ships described in this narrative, but there were many times that we wished that they had been installed.

For those who may not be familiar with them, a guarding valve (or double block valve, as it is sometimes called) is a second valve which is placed ahead of the frequently used service valve, and which is always kept open except when it is necessary to shut off the service for repairs. Since it should never be partly open and it is not subject to cutting from wiredrawing, it can more readily be depended upon for shutting off the piping system in an emergency.

There are several other items that should be carefully considered by design engineers. For one, I believe that the use of the *screwed bonnet* type of bar stock valve, for any *high pressure steam* or *hazardous gas* service, should be prohibited. These are light, small valves. On the last ship, we snapped the stem of one of the boiler gage valves in attempting to close it. Scale had caused the stem to freeze to the body. We had a lot of trouble with these valves leaking through the seat and the bonnet joints. For this reason, we attempted at the shipyard to pin the bonnets with taper pins. This made the valves even more useless, because once a leak was started, the valve could not be ground in without removing the pin; and, in case of a bonnet leak, they could not be repaired at all.

Mark Valves To Show Flow Direction

I have never seen a valve repacked under pressure and certainly no one would attempt it except in an emergency. But where an emergency does arise, what assurance has the pipefitter or repairman in the case of a *globe* valve that it is closed *against* pressure? From a flow standpoint, most engineers prefer to have globe valves installed to close against pressure. There are equally valid reasons for having the valves close *with* pressure, depending upon the service and danger involved.

But how can anyone tell which way a globe valve is *installed*, when for 95 percent of the valves there is nothing to indicate it. For this reason, it is my firm conviction that all such valves should be marked with an arrow to indicate direction of flow for closing against pressure. The use of the arrow should not cause undue confusion where the valve is required to be installed to close with pressure, and at least you would be sure of how it *was* installed. Check valves are marked in this manner—why not globe valves too?

NEW MATSON LINER IS AIR CONDITIONED

Balmy breezes prevail on the Pacific but the 722 passengers aboard the new Matson passenger liner Lurline have the additional luxury of controlling their own room temperature, for the ship is completely air conditioned. All passenger staterooms and crew living quarters, all dining saloons, lounges and other public rooms, as well as the ship's offices, are air conditioned.

Among the refinements of the air conditioning system is an auxiliary exhaust ventilating system for drawing smoke-laden air out of the first class smoking room.

In the ship's galleys exhaust ventilating systems draw off the hot air and allow air conditioned air to replace it.

The Lurline is one of the few passenger ships with air conditioned comfort for her crew.

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TESTS conducted over a period of three years indicate that resilient flooring materials for use over radiant heated subfloors can be selected by much the same standards as for rooms where conventional type heating systems are used, it is reported here. If floor temperatures are too high, they may be "uncomfortable underfoot and may result in excessive indentation of flooring"

Selecting Flooring Materials for Radiant Heating Jobs

RESULTS OF exhaustive tests by the Armstrong Cork Co. research laboratories indicate that resilient flooring materials for use over radiant heated subfloors can be selected by much the same standards as for over subfloors in rooms where convector-type or conventional heating systems are installed.

As a result of the increased popularity of radiant heating, and the demand for resilient floor recommendations where radiant heating is involved, the laboratories began conducting a series of continuous tests on the subject over three years ago. Observations were made of all types of resilient floors installed over various types of radiant heated subfloors.

Since the tests showed the effects of varying degrees of temperature on the hardness, composition, and indentation properties of resilient floorings, they make possible certain specific recommendations as to construction methods for radiant heating installations where resilient flooring is to be used.

One-inch pipe, spaced 12 in. apart and laid on insulating baffles, was used in the experiments. In this type of installation, the water temperatures were varied from 100 to 115 F and the general floor temperatures from 80 to 85 F, with the floor areas directly above the pipes 5 to 6 F higher. This was found to be satisfactory for the comfort of the room occupants and the service of the resilient flooring. In buildings where greater pipe diameters, wider spacing, or high water temperatures are to be used, special flooring recommendations may be required and should be obtained from flooring manufacturers; it is imperative, however, that regardless of the system of radiant heating used, the temperature of the floor surface should not exceed 80 to 85 F, according to the tests.

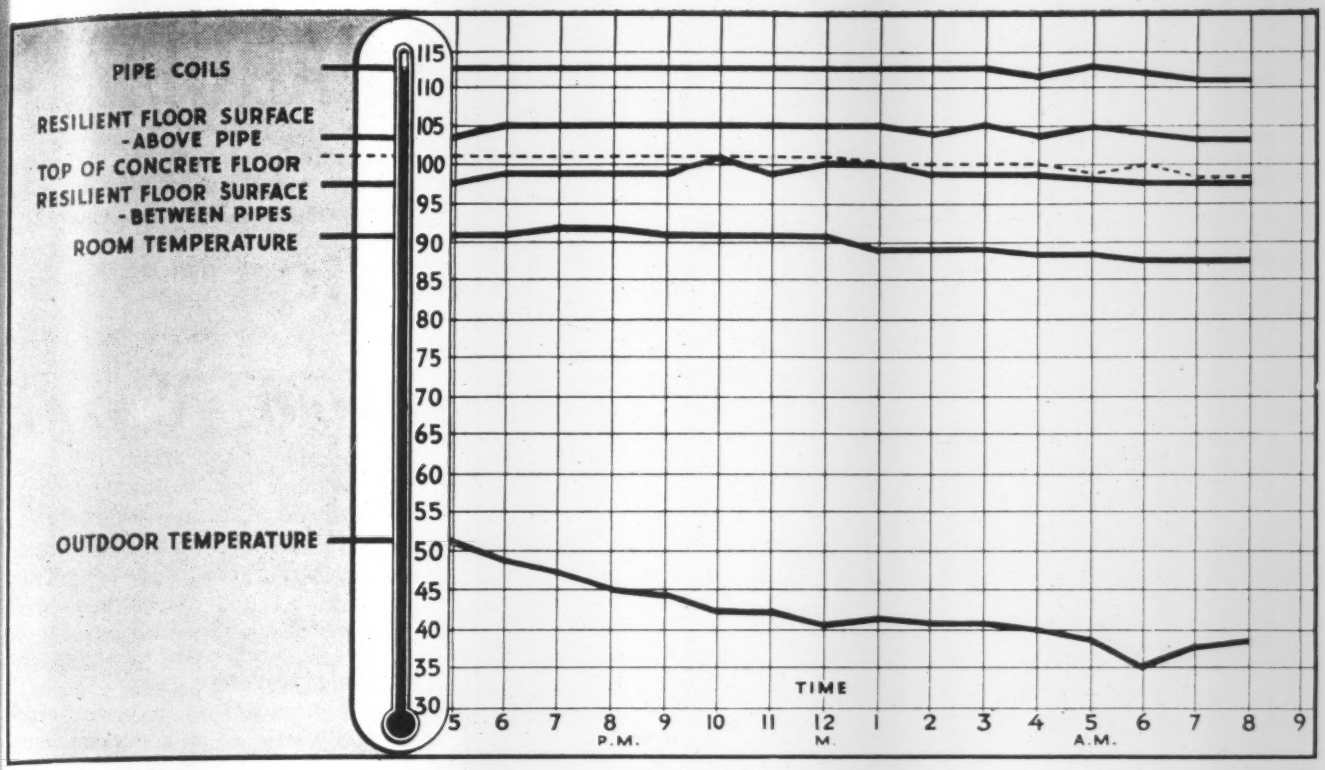
Limit Water to 120 F Temperature

The tests showed that it is desirable to limit water temperatures in radiant heating systems to 120 F. Temperatures above this point "are uncomfortable underfoot and, in addition, may result in excessive indentation of the resilient flooring, particularly in asphalt tile." While these laboratory experiments were designed to test resilient flooring under extreme temperature conditions, reports on field installations indicate that, in many cases, constant water temperatures ranging from 85 to 115 F are sufficient to maintain comfortable room temperatures.

With radiant heating, as well as with conventional methods of heating, linoleum, Linotile, and rubber tile should be used only on suspended floors or grade level floors with at least an 18 in. well ventilated air space beneath them. Asphalt tile can be specified also for above grade installations.

The tests showed that radiant heating normally does not create floor temperatures as hot as those resulting from the direct rays of summer sunlight. The same type of furniture rests and cups as normally used can therefore be used satisfactorily to protect resilient floor materials that are used with radiant heating.

The experiments were conducted by building concrete subfloors in four separate sections. Each section was designed to test various types of resilient flooring under the most extreme conditions that might be encountered with radiant heating on suspended, grade level, and below grade concrete subfloors. A controlled temperature, forced hot water system was used for heating. In order to direct the maximum flow of heat toward the surface of the floor, the radiant heating coils



This graph shows the potentiometer recordings for one test made during the experiments with resilient floors installed over a radiant heated concrete subfloor. During this particular test period, higher than normal room temperature was maintained. It is interesting to note that, while the outside temperature lowered, the temperatures of the surface of resilient floor and of the room interior remained fairly constant without any increase in the temperature of the water in the radiant heating coils

were laid on baffles made from 6 in. wide strips of 25/32 in. sheathing. Each type of resilient floor was installed according to standard specifications.

Twenty-seven electrical thermocouples were imbedded into the floor construction at strategic points to record temperatures. During the past three years, periodic recordings of the floor and room temperatures were made.

During the winter months of the three years when the tests were made, the outside temperatures ranged from 11 to 51 F. By maintaining the water temperature at 115 F, the room temperature varied from 72.5 with the window open to 90 F with it closed.

The resilient floor temperature varied from 83 to 101 F depending upon the room temperature and ventilation. A maximum resilient floor temperature of 105 F was recorded directly over the heating pipes. The temperature variance between the concrete subfloor and the resilient floor surface was about 1.5 F. It should be noted from these findings "that resilient flooring materials do not decrease the heating efficiency of the system to any noticeable effect."

To determine the effect of radiant heat on the indentation properties of the various types of resilient floors, indentation tests were made before and during the period the floors were heated. Using the test loads prescribed by federal specifications for each type of resilient floor, it was found that the radiant heated floor temperatures did not increase indentation beyond the specified limits.

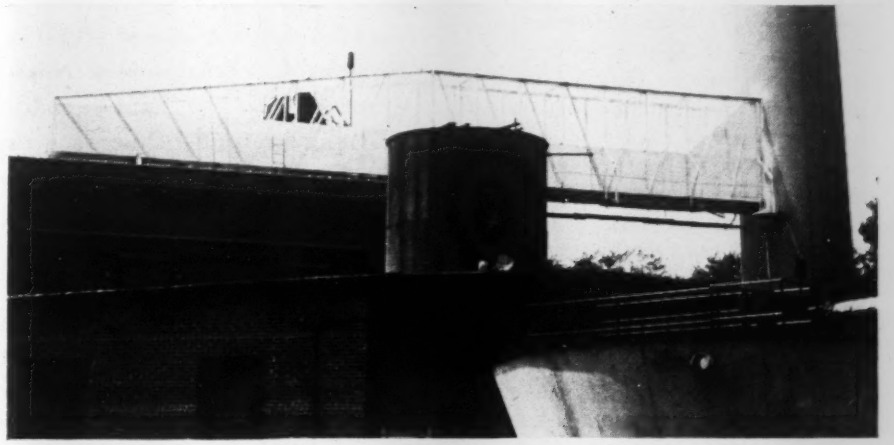
Effects of radiant heat on the adhesives used for installing resilient floors also were observed to result in no failure of the resilient floorings or their respective installation adhesives during the course of the experiments.

NEW SMOKE BREECHING FOR INDUSTRIAL BOILERS

An unusual new smoke breeching that runs from the power house to the chimney at the big plant of the Horner Woolen Mills Co., Inc., Eaton Rapids, Mich., is supported by a bridge-like structure. The breeching is fabricated of 3/16 in. wrought iron plate.

The breeching assembly was designed by Cummins and Barnard, Ann Arbor, architects and engineers, and installed by Jarvis Engineering Wks., Lansing.

This shows the unusual smoke breeching supported by the bridge structure



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SUCTION LINE HEAT EXCHANGERS—

Why They're Used In Refrigeration Work

PRACTICALLY ALL modern installations of equipment utilizing heat transfer apparatus of any type include many devices designed and intended to increase the overall efficiency of the installation. These devices take a variety of forms, but a great majority of them are themselves heat transfer devices and utilize waste heat or waste cooling effect from one piece of equipment to improve the condition or characteristics of the process material in another part of the system.

While these devices are in themselves usually small and inexpensive as compared to the other pieces of equipment which they serve, it is often the case that the satisfactory operation of the entire installation depends on their proper functioning and design. Particularly from the viewpoint of operating efficiency and economy, these devices assume an importance out of all proportion to their size and cost.

Since refrigerating systems—whether used for sharp freezing, air conditioning, or other purposes—are definitely heat transfer apparatus, it is natural to expect that some such device may be used to increase the efficiency of and to, in effect, compensate for some inherent shortcomings of some part of the system. These characteristics are possessed in their entirety by suction line heat exchangers. Their sole purpose is properly to condition the liquid refrigerant prior to its entering the expansion valve, increasing the efficiency of the compressor and thereby of the entire system. Other advantages are also gained by their use, but these are relatively minor.

From a practical operating standpoint, suction line heat exchangers directly reduce the running time of the compressor by materially reducing the flash gas in the evaporator. They also increase the overall coil capacity by lowering the temperature at or near the outlet end. Paradoxically, this lowering of coil outlet temperature is accompanied by an increase rather than a decrease in suction line pressure, which in turn increases the capacity of the compressor. Thus, it is certainly true that the value of a suction line heat exchanger is out of all proportion to its cost.

Whenever liquid refrigerant passes through an expansion valve, the reduction in pressure is accompanied by a reduction in temperature which renders the refrigerant capable of absorbing heat from a region of low temperature—thereby accomplishing the fundamental purpose of a refrigerating system. This liquid, therefore, must exist in the coil, immediately past the expansion valve, at a low temperature, for standard ton conditions, at 5 F.

Immediately ahead of the valve the temperature of the liquid was 86 F. Obviously, the cooling of this body of liquid from 86 to 5 F requires some refrigerating effect, and the only source of this cooling effect is the evaporation of a part of the liquid itself. This portion of refrigerant evaporated to cool the remaining refrigerant liquid is known as flash gas and its extent is determined solely by the difference in temperature of the liquid on the two sides of the expansion valve. The amount for a given set of conditions may be readily determined by reference to standard tables for the refrigerant in question.

Thus, for "Freon 12" and standard ton conditions, liquid at 86 F has a total heat of 27.72 Btu per lb and at 5 F has 9.32 Btu per lb. The difference is 18.40 Btu per lb. The latent heat at 5 F is 69.47 Btu per lb. Therefore, the percent of total liquid evaporated during expansion to cool the remainder to 5 F (flash gas) is 18.40/69.47 or 26.5 percent.

It is readily apparent that this represents a corresponding percentage of the compressor capacity which must be used merely to remove this flash gas from the evaporator. If it were not removed, the remainder of the liquid refrigerant would not remain at a pressure and temperature sufficiently low to accomplish its purpose. Since any flash gas that is generated in the

H. E. FERRILL, chief engineer, brass division, Kerotest Mfg. Co., Pittsburgh, explains how refrigerant suction line heat exchangers may be used to increase the efficiency of refrigerating systems by properly conditioning the liquid refrigerant prior to its entering the expansion valve. A second article will explain in detail how such exchangers act, and will give information on practical applications and uses.

expansion valve must be removed, it is essential that the amount generated be kept to a minimum. The percentage of liquid converted into flash gas is determined by the temperature difference between the two sides of the expansion valve; thus, it follows that if this temperature difference is reduced, the flash gas will be reduced accordingly.

What "Subcooling" Is

This reduction in temperature is known as subcooling, since it takes place at constant pressure and the resultant temperature is considerably lower than the saturation temperature corresponding to the existing pressure.

While passing through the condenser receiver and liquid line, the refrigerant remains at substantially a constant pressure, depending on the temperature of the condensing medium. It is characteristic of any fluid that the pressure and temperature remain constant during the extraction of heat necessary to change the fluid from the saturated vapor to the liquid state, or to condense. This process characteristically takes place at the saturation pressure and temperature. Accordingly, if the liquid is to be further cooled to a temperature below saturation, such cooling must of necessity be done in the absence of vapor, since any vapor present would condense, with a consequent lowering of pressure. In order, then, to bring about a constant pressure cooling, or subcooling, of the liquid refrigerant, it is necessary that a cooler for this purpose be installed as far from the condenser as possible. This obviates the presence of any vapor.

The purpose of such a cooler being to process the liquid supplied to the expansion valve, it is logical that it should be located as near that valve as is practical, in order that none of its effect be lost in the intervening liquid line. It follows then, that the efficient, logical, and practical location for a heat exchanger, installed for the purpose of subcooling the liquid refrigerant, is in the liquid line immediately ahead of the expansion valve.

The foregoing has demonstrated the need for some effective means of subcooling the liquid refrigerant. The most logical location for a device to accomplish this has been determined. It now remains only to find a source of cooling effect with which to remove this excess heat from the liquid refrigerant.

Source of Cooling Effect

Any source of cooling effect would suffice. Even if by subcooling the liquid we penalized some other part of the system, it could conceivably be demonstrated that the elimination or reduction of flash gas would increase the overall efficiency of the system by an amount sufficiently high to warrant such a penalty. However, it can easily be pointed out that, in the average refrigeration installation, there exists a source of cooling effect which is ordinarily wasted. The available cooling effect from this source is ample to accomplish a considerable amount of subcooling. In addition, its utilization brings into play other factors which increase rather than penalize the efficiency of other parts of the system.

Most thermostatic expansion valves are factory adjusted to maintain a superheat of approximately 10 F at the bulb location. If the bulb is properly attached at or near the outlet coil connection, the outlet end of the coil will accordingly operate at a temperature 10 F above the inlet end. In many instances, this setting is not sufficiently high to prevent the frosting or sweating of the suction line outside the refrigerated space. In addition to being extremely unsightly, this frosting or sweating will in time produce deterioration of wooden structures in contact with it, as well as possible damage to electrical circuits.

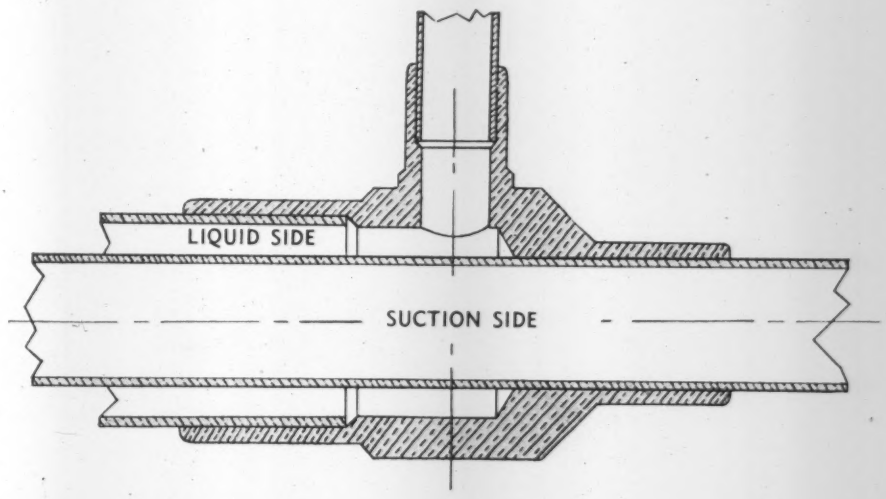
The usual remedy to faults of this nature is the readjustment of the thermostatic valve, maintaining a dry suction line by increasing the amount of superheat in the coil outlet. This has the effect of reducing the effective surface of the coil, and the inlet end must of necessity operate at a pressure and temperature lower than originally in order to handle the required load.

It follows then, that if the coil surface is to be used to maximum advantage at a uniform temperature, and if the suction line is to be maintained in a dry condition, a source of heat could very handily be interposed between the two.

It has now been demonstrated that a simple refrigeration installation contains at one location a definite need for the application of cooling effect to the process material; it is also true that the same system contains at another location a waste cooling effect, the utilization of which would accomplish our prime purpose as well as otherwise improve the efficiency of the system. It remains only to investigate the relative temperature ranges and quantities of heat involved in order to ascertain the compatibility of the two.

Liquid refrigerant passing through the liquid line will certainly not be cooler than the condensing medium. In cases of air cooled condensers in warm climates, the liquid will leave the condenser at a temperature at least 15 F above the air temperature. Subsequent cooling in the receiver and liquid line may lower the temperature another 10 deg, but this is about the most to

This is a typical fitting available for the construction of refrigerant suction line heat exchangers in the field



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be expected. Consequently, in air cooled machines the liquid refrigerant will have a temperature of about 90 to 95 F even in moderately warm weather.

Most water cooled machines are adjusted, in the interest of water economy, to maintain approximately an 80 F water outlet temperature. Refrigerant temperature would approach but never quite reach this figure, and 85 F would probably be a better average. Extreme weather and load conditions should be considered, since it is at these times that the system needs additional capacity. It will not be unsuitable, then, to consider for purposes of discussion the temperature of the liquid refrigerant to correspond to standard ton conditions, namely 86 F.

Considering the source of the cooling effect, the temperature of refrigerant vapor at different coil outlets varies widely, depending on the coil application. Average refrigerant temperatures range from the -20 to -25 F found on low temperature work through the standard commercial range of 5 to 15 F, up to higher temperatures of 30 to 35 F found in air conditioning applications. Comparing these temperatures with the 86 F liquid temperature, it is easily seen that, in any case, sufficient temperature differential exists to provide reasonably effective heat transfer. About the minimum difference encountered is on the order of 50 F, which is ample provided the heat transfer device used is efficient.

Referring to the standard ton conditions noted previously, it was found that the cooling of each pound of liquid "Freon 12" from 86 to 5 F required the removal of 18.40 Btu per lb. It is necessary that the suction vapor remove this heat by increasing its own superheat within its usual operating range.

Available Cooling Effect

Most summer air conditioning design work is done with design wet bulb temperatures in the neighborhood of 75 F. It is safe to assume then, that if the outside of the suction line does not fall below 75 F, it will remain dry. Allowing a reasonable temperature difference of 10 deg, the suction vapor should be superheated to 65 F prior to leaving the refrigerated space. If we adhere to standard ton conditions, the coil refrigerant temperature will be 5 F and the coil pressure 11.81 psig. Assuming a 10 deg superheat setting of the expansion valve, the coil outlet temperature will be 15 F. Conformity with the requirement of a dry suction line requires an additional 50 F of superheat and a final refrigerant temperature in the suction line of 65 F. Reference to standard tables of the properties of "Freon 12" shows this to require the addition of:

H @ coil outlet		
P	11.81	
T	15 F	.....81.23 Btu per lb
H @ suction line		
P	11.81	
T	65 F	.....87.35 Btu per lb
		6.12 Btu per lb

Comparing of this value with the 18.4 Btu per lb to be removed from the liquid, it can be seen that much can be done even without readjustment of the expansion valve.

If the expansion valve is readjusted to maintain 2 F superheat instead of the usual 10 F, the available cooling effect is materially increased:

H @ coil outlet (S = 2 F)		
P	11.81	
T	7 F	.....78.98 Btu per lb
H @ suction line		.....87.35 Btu per lb
		8.37 Btu per lb

Right Combustion Chamber Saves Oil

A program by which "savings of fuel oil of up to 25 percent could be accomplished" was outlined by J. D. McCullough of the Babcock & Wilcox Co. at a recent meeting of the New York Oil Heat Association.

"In the present critical fuel situation, many consumers do not realize," he said, "that the method of construction of the combustion chamber in which the fuel oil is burned is a major factor in the amount of oil consumed."

Maximum fuel oil savings depend on correct size of the combustion chamber, the method of construction, and the use of lightweight firebrick, he explained.

"Lightweight firebrick are able to accomplish fuel savings," Mr. McCullough stated, "because tests have shown that they can be heated up more rapidly than heavy firebrick. When an oil burner operates intermittently, the firebox cools while it is off. When the burner starts up again, the oil does not burn completely until the firebox is hot, and soot is formed during this period of incomplete burning. The soot represents wasted fuel and also covers the heating surfaces so they are prevented from efficiently absorbing heat. The faster heating-up characteristics of the lightweight insulating firebrick shorten the soot forming period from minutes to seconds. This not only saves fuel but reduces the necessity of frequent removal of soot from the heating system.

"The lighter the firebrick, the greater the fuel savings accomplished," Mr. McCullough said.

He outlined the following program as a means of conserving oil:

1) An appreciable amount of fuel oil could be saved if, when a new oil burner is being installed, the owner would make certain that the combustion chamber is of a size and design to give maximum efficiency, and that it is lined with lightweight firebrick.

2) An even greater saving could be accomplished by a general modernization program substituting lightweight firebrick for heavy firebrick now in use.

3) Replace fireboxes which have deteriorated with new fireboxes of proper design and made of the proper materials.

ACOUSTICAL RESEARCHER NAMED DIRECTOR

Dr. Haldon A. Leedy, chairman of physics research at Armour Research Foundation of Illinois Institute of Technology, has been named acting director of the foundation. He has engaged in various fields of acoustical research—noise reduction of industrial devices, study of noise produced by water flow through pipes and valves, noise and vibration study for the Chicago subway, and a noise survey for that city.

HIGH PRESSURE HOT WATER

What It Is and What Its Uses Are

J. R. KELL, chief mechanical engineer to Dr. Oscar Faber, consulting engineer, London, England, describes the fundamentals of using high pressure hot water for process requirements and space heating, and the reasons for employing HPHW systems. Further articles will consider piping layout, boiler installation, and general design

IN THE YEAR 1831, a British inventor named Angier March Perkins was granted a patent for a high pressure hot water system.

It was—at the time—revolutionary, and was an immediate success because it used pipes of small diameter, had a small water content, a rapid heating up rate, and a brisk circulation. It consisted of a closed system of 7/8 in. bore hydraulic piping, about one-sixth of which was wound in a coil in the furnace, and five-sixths of which formed the heating surface running "uphill and downdale" through the rooms to be heated. The joints were made with right and left hand threaded couplings. At the top was an expansion vessel, partly filled with air but sealed at the top. Frequently, two or more coils were intertwined in the boiler, each serving separate sections of the building.

Fig. 1 shows the system diagrammatically. It commonly worked at 350 F at the furnace, equivalent to 120 lb per sq in., but we are told that temperatures frequently rose higher—sometimes to 550 F, equal to a pressure of over 1000 lb.

The system was extensively used in churches, chapels, museums, libraries, country houses, offices, and large and small buildings of all kinds, and may, indeed, still be found at work here and there in unexpected places.

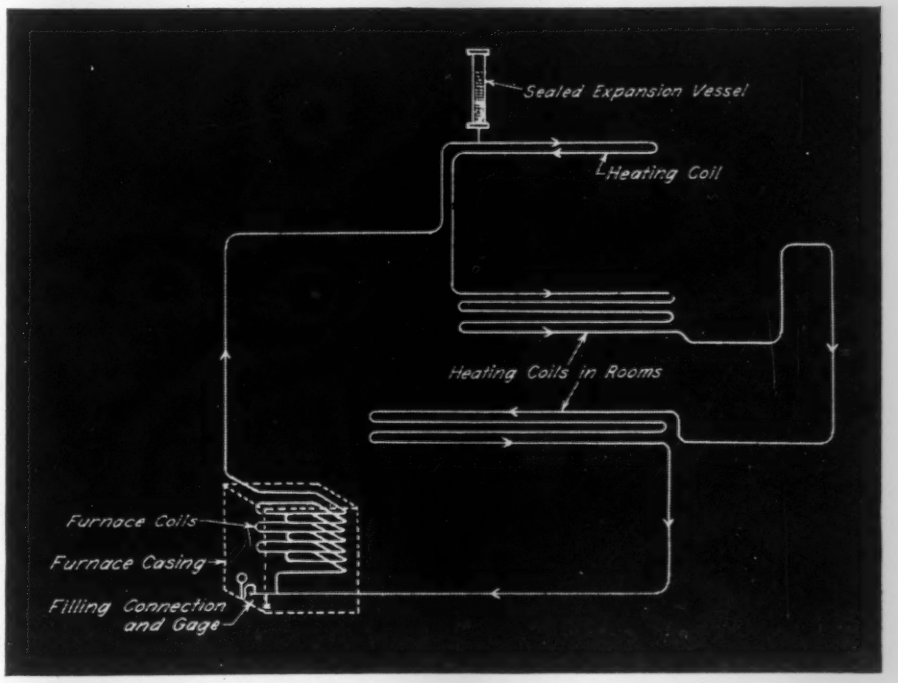
Low pressure apparatus with or without circulating pumps has, of course, now largely superseded this system for the kinds of buildings which it served. But it is interesting to reflect on the fact that this invention was just about 100 years old when its offspring came into the world in the form of the modern high pressure hot water system.

In the early 1930's, the kind of high pressure hot water system to be described in these articles was first introduced into Great Britain from Europe. Names such as Caliquar, Kranz, and Sulzer were first associated with these developments.

It arrived at a time of considerable industrial expansion, particularly in the motor trade. Many large and important installations were erected using high pressure hot water for the heating of factories, for supplying heat for enameling and drying tunnels, and for other process work.

By the time the 1939 war broke out, and a vast expansion of factory building took place, the system was fairly widely known and understood, and it was adopted as a method of heating on a large scale.

Fig. 1—The Perkins system, patented in 1831, was a forerunner of the modern high pressure hot water system. It consisted of a closed piping system, about one-sixth of which was wound in a coil in the furnace and five-sixths of which formed the heat emitting surfaces



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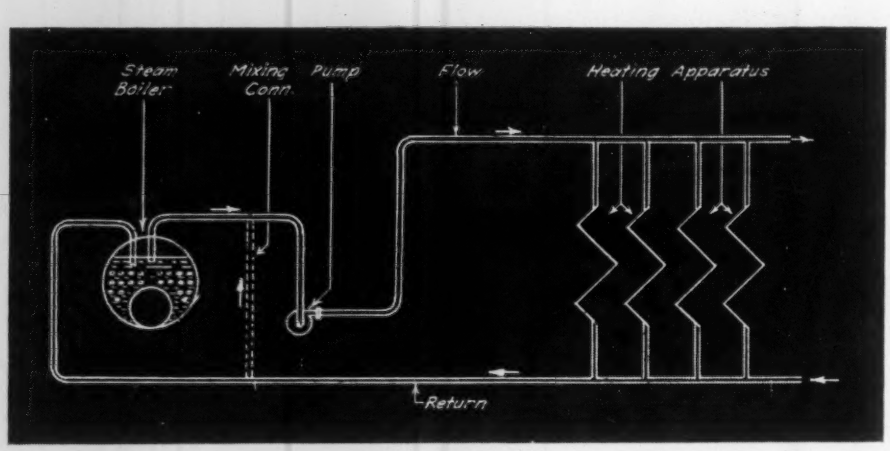


Fig. 2—The modern high pressure hot water system (HPHW) uses water under an elevated pressure so that the temperature may be raised above the normal boiling point.

Systems as large as 200 million Btu and as small as three million have been installed in such buildings as aircraft factories, ordnance depots, and large scale industrial estates, sometimes covering in one site many hundreds of acres.

The modern high pressure hot water system, or "HPHW" as we will refer to it, uses water under an elevated pressure so that the temperature may be raised above the normal boiling point. The system is shown by the diagram in Fig. 2.

The boiler may be an ordinary steam boiler. The water below the steam surface is circulated through the system by pump.

The temperature of operation is commonly 300 to 350 F, being determined by the pressure chosen. The return may come back with a 100 F drop; thus, each pound of water circulated will carry as much as 100 Btu when this is the case.

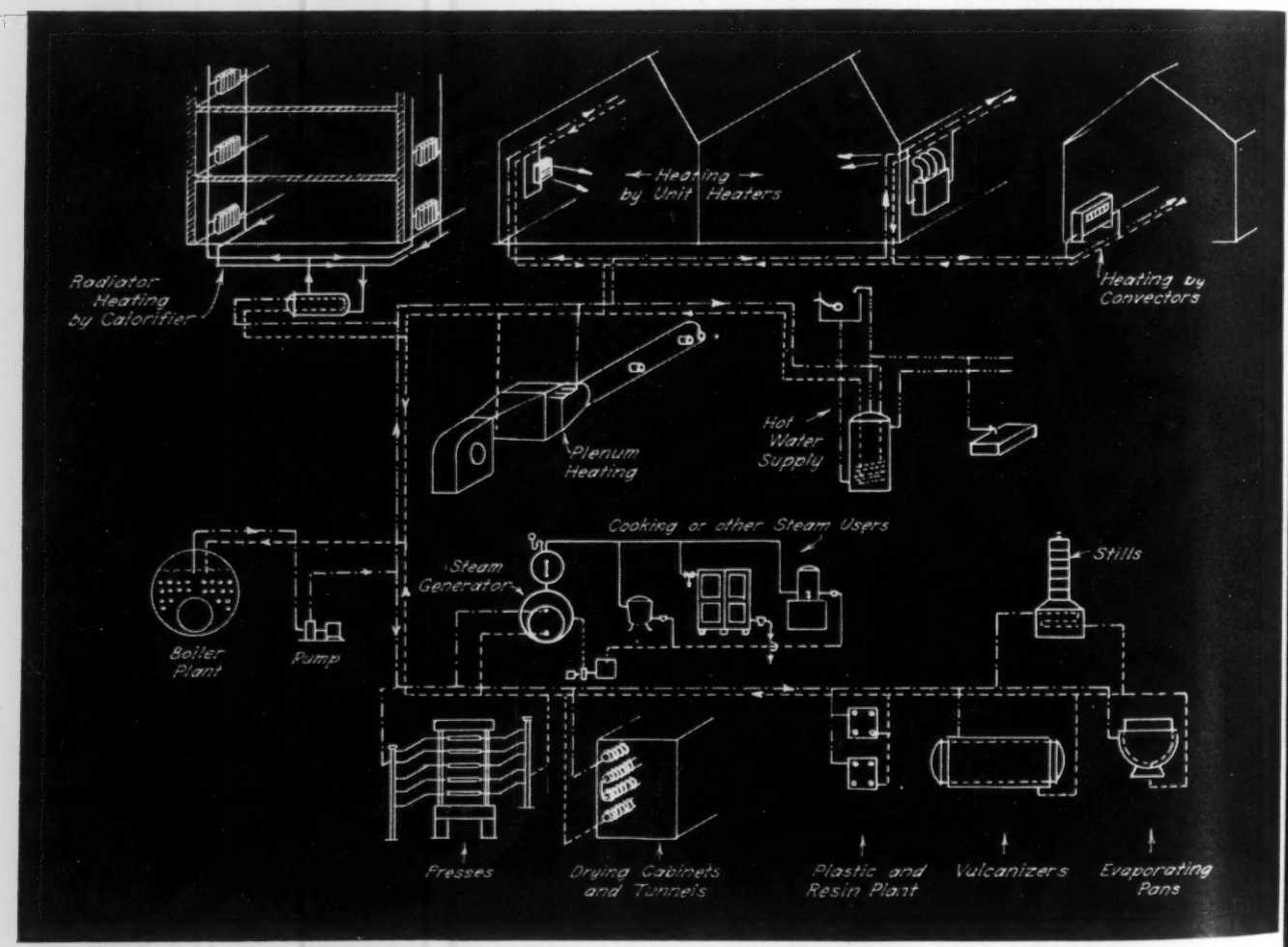
The water of expansion is accommodated in the steam space of the boiler; though other types of boilers using a separate drum are frequently used, in which case the drum takes up the expansion.

No steam is drawn from the system normally, so that the only make-up required is that due to leakage and blowing of safety valves, etc. This make-up is supplied by ordinary boiler feed pumps.

It will be seen that the temperature of operation of this system may be varied to suit the weather and other considerations, being limited only by the safety valve setting of the boiler.

There are other methods of maintaining pressure in the system. In the example shown in Fig. 2, the steam creating the pressure is generated as the boiler is fired, so that temperature and pressure rise together. This is the most common

Fig. 3—High pressure hot water is used for various process requirements as well as space heating. This is a diagram of a combined heating and process system



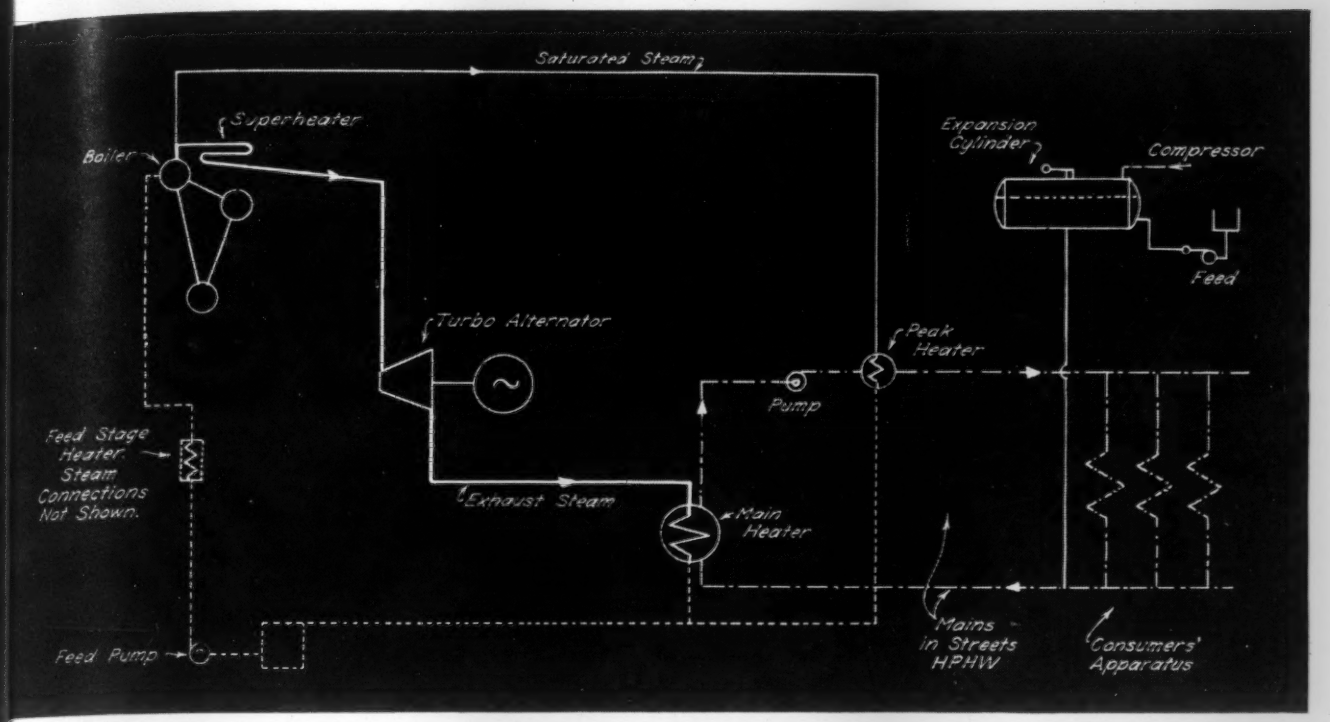


Fig. 4—District heating system using high pressure hot water

arrangement. Designs have been produced, however, in which pressure is maintained by air from a compressor, acting in a separate closed vessel connected by pipe to the system. The boiler is then completely filled with water, and runs at constant pressure, but again with the facility for variation in temperature.

A further scheme has no expansion vessel of any kind, but a continuously running feed pump holding the required static pressure. In this case the water of expansion is bled off through a loaded relief valve into an external feed tank, to be later fed back by the feed pump.

Uses for HPHW

HPHW can do such industrial heating jobs as heating the factory, hot water supply, cooking, and process work. A combined heating and process system is shown in Fig. 3.

For heating, use can be made of unit heaters, plenum batteries, convectors, and flat plate metal radiant panels. Low pressure hot water systems can be served by means of calorifiers (heat exchangers).

Hot water supply for taps is provided by means of water-to-water calorifiers.

Steam for cooking and other low pressure duties may be obtained from steaming calorifiers with HPHW passing through the coils.

Process requirements may be served by HPHW in such equipment as dye vats, plating shop hot acid and washing baths, boiling vessels, evaporators, and the like. Enamel drying tunnels and drying kilns of all types have been developed with HPHW supplying the heat. Vulcanizing, plastic, plywood and veneering presses and platens can similarly be adapted or designed for use with HPHW. In all cases of process service, this system has the advantage of uniform and rapid heating, with the facility for temperature variation by simple hand valve regulation of the water volume flowing or by mixing bypass.

Any one or all of these duties may be served from one set of mains connected to a central boiler house. The boilers may serve one building or any number of separate detached buildings, with mains run overhead or in pipe trenches or tunnels.

There is no technical limit to the size of installation possible or to the distances which can be covered. The limits are generally economic, as at some point pumping costs and main losses will begin to outweigh the cost of duplicating the boiler plant.

Variations in site level are unimportant, provided parts of the system are not elevated to such an extent that ebullition may occur through the lowering of pressure. If considerable differences of level are met with, it may be necessary to site the boiler house on the highest ground so that the rest of the system is under a greater pressure than the boilers. This is the opposite of the steam case, where for convenience of condensate return, the lowest point is generally preferable for the heating station.

For the same reason, very high buildings cannot be served by HPHW unless one of the alternative designs is followed, in which pressure is maintained independently of temperature, or use is made of heat exchangers.

Back pressure or pass-out steam from an electric generating plant may be advantageously used in conjunction with HPHW through heat exchangers. In this scheme, the steam circuit is confined to the heat station, frequently allowing the use of lower exhaust pressures.

Since the motive power for circulation of the water is independent of the pressure of the steam supplied, the waste heat may, with HPHW be conveyed over considerable distances—as, for example, in a district heating system.

Many of the district heating plants installed in Russia and Germany prior to the war adopted this method. The Russian examples

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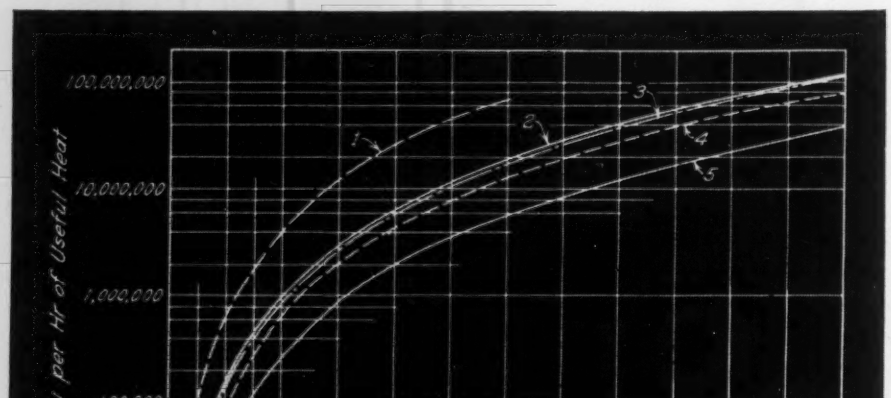


Fig. 5—Comparative pipe sizes for high pressure hot water and steam. Curve 1, condensate returns (for steam). Curve 2, high pressure hot water at 100 F drop or steam at 150 psi. Curve 3, steam at 100 psi. Curve 4, steam at 50 psi. Curve 5, hot water at 30 F drop. Assumed pressure drops are 0.1 in per ft run for water, and 1 lb per 100 ft run for steam

commonly work at a flow temperature of 240 F, with a return of 160 F, using back pressure steam, and with peak heating direct from the boilers from 240 to 275 F for use in cold weather. The arrangement of this type of system is shown diagrammatically in Fig. 4. The German examples have in some cases included a heat accumulator to balance out the power and heating loads.

What Are HPHW's Advantages?

What are the advantages of HPHW? It is a controversial issue, and already one paper has been presented to the British Institution of Heating and Ventilating Engineers, when the pros and cons were vigorously debated. The main advantages claimed by advocates of HPHW were economy of fuel, facility for adjustment of temperature to suit varying weather conditions, freedom of location and level of piping, absence of return line corrosion, and saving of feed water.

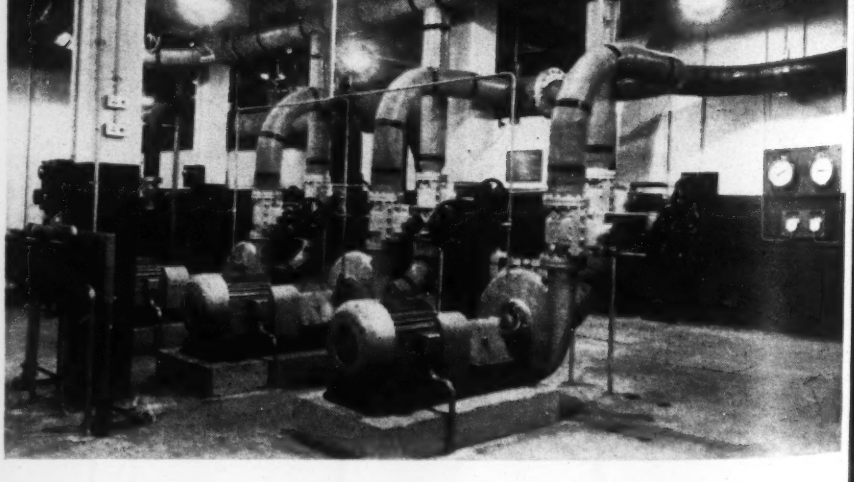
The economy of fuel is said to arise from the absence of flash steam from trap discharges, absence of vapor losses at the hot well, and from the numerous other steam escape points over a large system, and absence of blowdown loss. It is easy to show that if steam is discharged from a trap at, say, 50 lb gage pressure, it retains in the water of condensation 267 Btu per lb. If this is passed into a condensate return line, some of the heat may be recovered if the piping runs through a building to be heated, but it is frequently mostly lost. On arrival at the hot well, even if it has cooled to the boiling point, 212 F, it still is suffered to drop to some lower temperature, such as about 180 F, before it can be fed into boilers. Thus, there is overall a loss between 267 Btu and 148 Btu contained in the water at 180 F which represents something over 10 percent of the initial heat in the steam at 50 lb (above 180 F). This is given only by way of example; at higher pressures, the steam loss is greater. Engineers are well aware of this fact and try, by various means to overcome these losses, such as by making use of low pressure apparatus where possible, cooling legs, condensate economizers, etc.

Bearing in mind also the other potential economies possible with HPHW, it can be seen that substantial fuel savings are possible. Actual examples have been quoted where conversions have been made to HPHW showing savings in fuel costs as high as 25 percent after allowing for the power consumed in the circulating pumps.

Temperature variation to suit weather conditions can be achieved with HPHW to a considerable extent. The water flow at the boiler can be varied from maximum saturation temperature, down to anything desired—either by allowing the boiler pressure and temperature to vary, or by mixing return water with the flow and keeping the boiler temperature constant. The latter method would be necessary if process requirements are served with a separate set of mains carrying constant temperature water. This facility for adjustment of water temperature to suit weather and to give a lower night heating rate, can mean a considerable saving in fuel, particularly if the control is effected thermostatically.

The next point mentioned in favor of HPHW was freedom with which piping could be run regardless of levels. This applies frequently on a large and complicated fac-

High pressure hot water circulating pumps in a typical installation



tory site where numerous roads, rail tracks, etc., have to be crossed, and where piping has to be run overhead through sheds, or underground through ducts, sometimes on a sloping site, and so on. The HPHW system has no whims or fancies as to where or how pipes are run, so long as they are left free to expand or contract, and so long as provision is made for removal of air at high points, and collection of mud or dirt at low points.

Corrosion of return lines is an old problem on which a good deal of research has been and is being carried out, and there is no need to enlarge on it here. The HPHW system has, of course, no such problem, since the same water is circulated 'round and 'round, and once it has exhausted the potency of its initial corrosive agents, if any, it ceases to have any appreciable chemical action. This statement should be qualified by pointing out that certain precautions are necessary to achieve this desirable aim, which will be referred to later.

The last point mentioned in favor of HPHW was in connection with the saving of feed water. The feed water necessary for a HPHW system is generally of the order of 1 percent or less of the hourly equivalent evaporation. It is only because some of the steam is sometimes used for soot blowing that any make-up at all is required, apart from chance leakage or blowing from safety valves. The smaller quantity of feed means less cost of treatment, and less sludge or scale in the boiler.

Disadvantages of HPHW

One disadvantage of HPHW is the large water content. This has three consequences: (1) The system takes longer to heat up initially. (2) It takes longer to cool down when a repair or alteration has to be made, and a good deal of water has to be discharged. (3) The water content, if allowed to escape through a break, being above atmospheric boiling point, partly flashes into steam, giving it a powerful disruptive effect. It is only fair to say that such occurrences are rare, and few serious accidents have been reported.

Another disadvantage is that a HPHW piping system cannot be added to with impunity. A new circuit, added without due regard to the balance of the system as a whole, may lead to short circuiting in one part and a deficiency of heat in another.

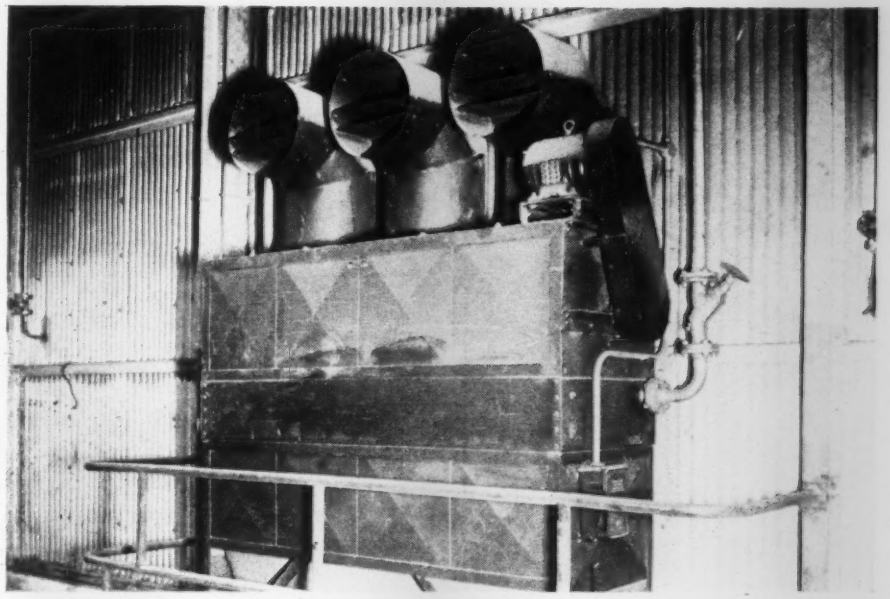
One last point against HPHW may be mentioned. It is that some of the earlier systems suffered through lack of attention to feedwater treatment, and the free use of steam taken from the boiler drum. This led to deposits and encrustations occurring throughout the system, causing stoppages in heating elements; seizing up of valves, etc. With proper design, these troubles should not arise.

Equipment Required

Fig. 5 shows the relationship in the matter of pipe sizes, taking steam at various pressures and HPHW at a 100 F drop. Certain assumptions as to pressure drops have been postulated in line with an average case. It will be seen that HPHW is on a par with steam at 150 psi, whereas at lower steam pressures, HPHW sizes are less.

With HPHW, two pipes of equal size are required as against one for steam plus a smaller condensate line. On the other hand, a steam system calls for traps, drip points, condensate return units, reducing valves, and other appurtenances.

In the boiler house, the boiler feed pumps and hot well necessary for a steam system are replaced, in the case of HPHW, with a smaller feed tank and pump for make-up water only, but in addition, circulating pumps must be included.



Unit heater, showing the high pressure hot water connections

The heat emitting surfaces will probably not differ much between the two types of systems.

It is impossible to make a true comparison in the face of so many variables without taking out costs both ways on an actual case.

OIL SAVINGS PAY FOR MAINTENANCE

Thousands of gallons of fuel oil can be saved each week by properly adjusting burners in heating systems, according to preliminary results of a continuing survey which were disclosed last month by the Socony-Vacuum Oil Co., Inc.

Proper burner adjustments, "requiring only about an hour's work by experienced burner maintenance men, may save fuel oil users as much as 25 percent in extreme cases on their annual bills," the survey indicates. These savings would more than offset the cost of the adjustments in practically all instances.

Company officials emphasized that their conclusions were based only on burner adjustments, whereas still greater savings in fuel oil could be obtained in many cases with changes in combustion chambers and burner nozzles and installation of draft regulators and baffles.

Although not included in the survey, a specific case cited was that of a school in upper New York state which used 12,740 gal of fuel oil last year. Major changes this year, which cost about $400, resulted in a 50 percent saving in fuel oil.

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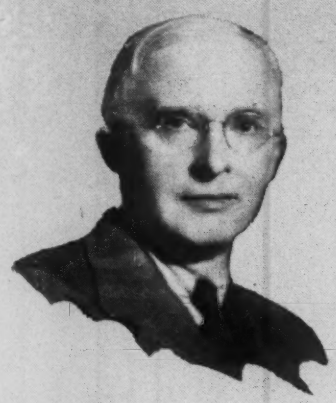

SAM LEWIS' PAGE

Informal comment on heating, piping, and air conditioning matters is given in this regular feature by Samuel R. Lewis, consulting mechanical engineer, member HPAC's board of consulting and contributing editors

'Lessons of 1948' Noted for Reference in Future

The importance of leaving room for expansion of an industrial plant boiler installation is indicated by a 20 year old job that must now be expanded. . . . How to handle cafeteria ventilation and heating is another "lesson" noted here for the benefit of the author as well as his readers

It seems expedient to record some "lessons of 1948," partly because by writing them I may not forget them but principally because they might help a friend.

Twenty years ago I designed a 150 psi heating system for a large industrial plant. The three water tube, stoker fired boilers were supposed to be the ultimate in capacity. It was expedient to face them eastward, close to the coal-delivering railway. The chimney was centered on the middle boiler and west of the boilers, as seemed economical for the breeching.

There was a large reserve coal storage bunker with mechanical conveyors adjoining the boilers on the south. The engine room—with water treating equipment, feedwater heater, pumps, compressors, etc.—was north of the boilers. Thus, the boilers were very effectively circumscribed.

Now the industry has grown. Acres of new warehouses and shops must be built, and some of them must occupy the coal bunker area and even will hedge in the chimney. The steam demand is doubled. There is no place in the boiler house for any more boilers. We do not own the main line railway, so we cannot go east.

I might—at no particular additional cost 20 years ago—have left at least the north end of that rather nice boiler plant open for future expansion. I could have located the feedwater equipment westward behind the boilers north and south of the chimney, so that now we might add two or three larger boilers to the north, and might go on indefinitely in that direction.

To move the engine room so as to give clearance for new boilers, while still maintaining service, will be expensive. Probably the answer will be an entirely new boiler plant in a different location.

Please, may I remember in the future to leave an expansion spot somewhere?

Ventilating an Employees' Cafeteria

Another manufacturing plant of colossal size has an employees' cafeteria. (I didn't design it.) The room is about 16 ft high. At one end there is an open kitchen, with gas range, steam tables, and coffee urns. There are no windows. A dishwashing annex about 10 ft square adjoins the main room. Above the dishwashing room, on a mezzanine floor, there is a unit ventilating supply fan with filters and steam coils, and it can deliver about 4 cfm of air per sq ft of cafeteria floor area.

A duct from this machine delivers air into the cafeteria through four diffusers in the high ceiling. An exhaust fan removes air from the cafeteria through the ceiling at one end of the room, as well as through the ceiling of the dishwashing annex, close to the always-open door into it from the cafeteria. There is a recirculation air duct leading from grilles close to the cafeteria floor back to the air supply machine.

There is a cross-connection be-

tween this return air duct and the inlet to the exhaust fan.

Dampers are provided in the following ducts:

a) Outside air intake to the supply unit.

b) Recirculation air intake to the supply unit.

c) Air intake from the adjacent heated warehouse to the supply unit.

d) Openings near the cafeteria ceiling to the heated warehouse.

e) Connection from the cafeteria recirculation duct to the exhaust fan.

f) Connection from the cafeteria ceiling above the heated equipment to the exhaust fan.

g) Outlet from the exhaust fan.

Dampers (a), (b), (c), and (d) each are in two halves, alleged to permit use of half of each kind of air as persuaded by a set of pneumatic three-way switches mounted on a gage board. Dampers (e) and (f) are to respond to still more switches. There is a room thermostat acting as pilot to a thermostat in the discharge duct from the supply unit and ultimately opening and closing a valve on the steam supply to the heating coil on the unit. There are vacuum traps to drain the steam supply main and the heating coil. Compressed air comes from the plant compressors hundreds of feet distant.

The Cafeteria Is Too Hot

The cafeteria is too hot. The fans are operated and looked after by the gentleman who washes the dishes. The ventilating system is only about four years old, but I found the following things wrong:

There is no compressed air to work the thermostats and dampers, since the air lines are full of oil.

The heating coil is leaking, probably from copper tubes split by frost.

The steam pressure on the coil is 60 psi due to a defective pressure reducing valve.

The vacuum traps are open, due to thermostatic bellows ruptured by high temperature and steam pressure.

The recirculation duct is open both to the exhaust fan and the supply fan, who thus are competing for the super hot air at the cafeteria ceiling.

The dishwashing gentleman is delighted, being in the strong draft coming into his annex at 6 ft door level on its short cut to the exhaust fan. He is by nature a warmblooded soul, anyway.

The air delivered into the cafeteria by the supply fan when taken from outdoors (as it may be upon the rare occasion when the right switches are manipulated and if compressed air is available) flows across the ceiling to the exhaust fan intake and never does get down to the level of the good souls who ingest their sandwiches and coffee. Incidentally, the heating of this cafeteria is no problem in cold weather, because it has a wonderful radiant floor—this being the concrete slab above the main plant steam pipe tunnel.

How to Correct the Ventilation

Of course the following immediate prescriptions, pending a refrigerated air conditioning system, are obvious:

Simplify the controls by eliminating the unwise and too complicated 50 percent switches and dampers.

Cut out the competition between recirculation and outboard exhaust by removing the duct.

Eliminate the useless and objectional mix-up with the air from the heated warehouse.

Install a hood or suspended wall from the ceiling down to about 7 ft above the floor over the cooking and hot plate area in the cafeteria, so that the entering air must flow down under this hood on its way to the exhaust fan.

Cut out the short circuit of air to the dishwasher annex doorway and take some exhaust from the dishwasher annex at a point remote from this doorway and directly above the washer, so as to catch the vapor.

Repair the heating coil and the vacuum traps, adjust the steam pressure to not over 5 psi, and install a safety valve with a whistle on it so as to tell the management to protect the traps in the future.

Try to make the plant management treat this very important equipment, so potent in its influence on production, as decently as the other production machines are inspected and maintained.

REPORT AVAILABLE ON HIGH VELOCITY VAPORIZERS

Latest scientific findings on high velocity vaporizers are presented in a research report now on sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C. The report is based on work done under a contract with the University of Illinois.

The report, by E. W. Comings, C. H. Adams, and E. D. Shippee, describes a method of vaporizing relatively high boiling or thermally unstable liquids into a hot gas stream. The need for such a method during World War II resulted in a simple and unique type of vaporizer, the researchers state. "The usual commercial methods for vaporizing such liquids would involve vacuum evaporation or evaporation in a suitable packed tower. These methods either required too large a volume for a given capacity or tended to hold the thermally sensitive liquid at a high temperature for too long a time." The simple vaporizer developed found application in the generation of screening smokes and colored signal smokes.

The principles involved in the developments outlined in the report have peacetime applications, the report continues. "Information on the design factors which influence atomization, the drop size spectrum from atomizers of differing design, the distribution of liquid droplets in a gas stream, the relative velocity of drops to gas, and the actual energy consumed in the atomization were found to be almost totally lacking at the time the developments were made."

The report contains two diagrams illustrating pressure distribution of a venturi type, high velocity vaporizer and the internal arrangement of a smoke pot. Copies of the 12 page report (PB-80858; High Velocity Vaporizers) are available from OTS at $1.00 in either microfilm or photostat form.

R. A. WASSON HEADS FAN MANUFACTURERS

R. A. Wasson, vice president and general manager of the Clarage Fan Co., was elected president of the National Association of Fan Manufacturers at the NAFM's 31st annual meeting, and T. J. Flanagan, president of the Garden City Fan Co., was named vice president of the association.

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Practical Pointers on

RADIANT HEATING

WITH REGARD to R. G. Vanderweil's opinion on floor versus ceiling coils for panel heating, as expressed in his article in the March HPAC, I should like to concur to the extent that I feel there are advantages to both locations and that the choice between the two must be based upon the particular problems peculiar to each specific type of structure.

I honestly believe that Mr. Vanderweil has overlooked one of the most important advantages of a floor type system when he fails to mention the ability of an installation of this kind to provide maximum comfort with concrete slabs on grade. While it has been claimed that a ceiling type system will produce a higher floor surface temperature than would be the case with a conventional system, it seems to me to be nothing more than wishful thinking to expect a warm ceiling 8 to 15 ft above the floor to drive the dampness and coldness out of a 4 to 6 in. thick concrete slab.

I would also question the advisability of expecting a ceiling system to prevent dampness beneath heavy floor coverings placed on concrete ground slabs, or to have much of a drying or warming effect upon floor areas covered by furniture and other objects which completely shield the floor from the heat radiating from the ceiling.

In multistory structures, the placement of piping in an intermediate slab produces a combination floor and ceiling system and thus in cases of this kind the location of the coils can usually be determined on the basis of cost and structural design. Where the intermediate sections are of frame construction it is entirely possible that the cost factor will swing in favor of a ceiling system. This may be true because the poor thermal characteristics of wood and air generally necessitate the installation of a greater amount of piping than would be required for a plaster ceiling system and they also require a higher operating temperature, which would adversely affect fuel costs.

Mr. Vanderweil suggests that the panel output be kept within allowable limits and there can, of course, be no objection to that point as stated. The problem, of course, is to fix the allowable limits and up to the present time attempts to establish limits have resulted in a wide difference of opinion. Fortunately for radiant heating, practice has proved theory to be extremely conservative and it is becoming more and more apparent as field investigations are continued that the floor type of system is capable of handling, without discomfort, the heating requirements in all but the most unusual of buildings.

Sizing Boilers for Radiant Heating

I am inclined to agree with Mr. Vanderweil's conclusions regarding the sizing of boilers for radiant heating systems. It is fairly well established that with minimum design conditions—the conditions upon which a boiler is sized—a radiant heating system will require smaller boiler capacity than a conventional installation. This appears quite logical when we consider that a radiant heated space may be kept at a few degrees lower air temperature, convection losses caused by air sweeping across cold surfaces are lower, and air stratification is almost totally lacking. This problem, however, requires more study and research.

One of the most controversial points in the whole subject of radiant heating is that of control. Despite the stated opinion of apparently capable individuals that floor type systems in particular create serious control problems, our records of well over a thousand installations have failed to reveal more than a negligible few cases of unusual structures where control difficulty of any kind existed. Since it may be assumed by some that we are of biased opinion, I should like to quote a reputable and thoroughly capable contractor who has completed at least 100 installations of the floor type:

"A lot has been written concerning temperature control, and overriding and under-shooting of temperatures, as well as lags in the heating-up period.

"We have not experienced any trouble along those lines. Practically all our jobs are controlled with the conventional room thermostat using a relay to start the burner and circulator at the predetermined temperature level. A structure that has an exceptional amount of glass facing the sun will heat up beyond desired room temperature unless some method is used to shade the glass. But this is true regardless of the method of heating, unless a separate system of zoning and controls is used.

"The final answer to this problem

"OPEN FOR DISCUSSION"

DO YOU HAVE something to say about any of the articles published this month? An additional comment, or perhaps a question on some point? We follow here the custom of engineering society meetings in allowing a period for discussion following presentation of a paper. You are invited to contribute your views. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

is the opinion of users. We have yet to learn of a single case where the owners were not most enthusiastic about radiant heating. All are so well satisfied that they will boost their system until listeners are bored."

There are other competent individuals whose experience is identical to that quoted above and thus I believe that we are fully justified in coming to the conclusion that if thousands of installations have operated in all types of buildings in all sections of the country for one or more heating seasons without a control problem of noticeable magnitude, the occurrence of control difficulties in a few scattered instances must be the result of some design, installation, or operation faults which can be corrected and thus should not be used as an index to determine the temperature control characteristics of a properly designed, installed, and operated radiant heating system.

Suggested Procedures for Venting

Mr. Vanderweil has touched on a very important point when he brings up the question of venting. Experience has developed a few suggested procedures, some of which may provide information in addition to that given in his article. One contractor has told me that he makes a practice of filling the system through one main only, thereby minimizing the danger of pocketing air in the coils or grids which may happen if both mains are filled at the same time. Another engineer-contractor brings a separate return line from each coil or grid back to a manifold in the boiler room. The returns are, of course, valved at this point and by filling one coil or grid at a time the removal of air and dirt has proved to be relatively simple.

Both of these practices are more applicable to one-level installations than to systems having the boiler at a lower level. In multistory buildings or in systems having the boiler on a different level, Mr. Vanderweil's suggestion of creating a high point has proved workable. Some installations are merely provided with pitched mains with vents at high points, while in other cases risers have been extended a foot or more above the level of the coil piping and equipped with vents at the top. The use of an air eliminator on the supply main in the boiler room is always considered good practice since, as Mr. Vanderweil stated, air is released in the boiler during the heating operation.

There is also a rather ingenious valve on the market which is designed for use as both a balancing and a venting unit to be installed with each coil. A number of installations are equipped with these valves and to the best of my knowledge they have proved highly satisfactory.—PAUL S. PARK, manager, engineering service dept., A. M. Byers Co., Pittsburgh.

NATURAL GAS RESERVES ESTIMATED HIGHER

Proved natural gas reserves in the United States on December 31, 1947 were 165.93 trillion cubic feet and proved liquid hydrocarbon reserves were 24,741,660,000 barrels, it was estimated last month in a joint report of the committee on reserves of the American Gas Association and the American Petroleum Institute. On December 31, 1946, proved reserves of natural gas were 160.6 trillion cubic feet and total liquid hydrocarbon reserves were 24,036,779,000 barrels.

FAST WORLD THESE DAYS

It's a fast world these days. In a paper on Passenger Service Requirements for North Atlantic Operations, by J. W. Schwab of Trans-Canada Air Lines, published in the journal of the Engineering Institute of Canada, the author said that with the use of jets and the resulting increase in speed "it is doubtful if trans-Atlantic flights will be of sufficient duration to warrant berths" for sleeping accommodations.

APPOINTED TO STANDARDS COUNCIL

Rowland Tompkins of Rowland Tompkins and Son, New York City, has been appointed a member of the standards council of the American Standards Association by the Heating, Piping, and Air Conditioning Contractors National Association, Vice-Admiral George F. Hussey, Jr. USN (Ret.), secretary of the ASA, has announced. Mr. Tompkins has had experience in the technical work on standards through his membership on the sectional committees on pipe flanges and fittings, and on unification of rules for the dimensioning of furnaces for burning solid fuel.

Unprecedented Volume of Repair and Maintenance

The building industry has carried out an unprecedented volume of maintenance and repair work in addition to producing new housing at a near-record rate, Melvin H. Baker, chairman of the Construction Industry Information Committee, reported last month.

"Considerably more than half as much was spent on maintenance and repair as on all new construction in 1947," Mr. Baker said. "The Department of Commerce's latest estimate of maintenance and repair value for 1947 is $7 billion, compared to $12.8 billion for total new construction. This repair and maintenance activity broke all records. The prewar peak year was 1941, with a volume of $3.9 billion. In 1946, the volume was $5.6 billion.

"This means that the country was catching up on deferred repair needs at an abnormally high rate at the same time that great demand was being placed on the industry for new homes to meet the shortage. The extent to which existing buildings were improved is demonstrated by the huge expenditures for repair and maintenance.

"The Commerce department's forecast of $8 billion for repair and maintenance in 1948, together with its estimate of an 18 percent rise in the volume of new construction, will mean a further improvement in the existing housing supply and will require that another new record be attained in the output of building materials during 1948."

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How Can We Simplify Operation and Maintenance?

IN A QUESTION published in the February issue of HPAC, "J.W." asked for suggestions to promote ease of maintenance and operation of air conditioning and ventilating systems. He said:

"We want to make the air conditioning and ventilating equipment installed in our buildings as accessible as possible in order to simplify its operation and maintenance with the idea of achieving better and more efficient results.

"One thing we have done is to install full-size sheet metal doors in the duct work to allow easy access to filter banks, etc., and these have proved a great help to the operating men.

"I'd be interested in any other practical ideas on how to arrange and install ventilation and air conditioning systems to promote ease of maintenance and operation."

Whoever has once experienced a breakdown of an air conditioning plant for reasons which seem to be trifling will certainly approve of "J.W." 's intention to do the possible to facilitate maintenance and operation by well-planned means.

Sheet metal doors in the duct work should be applied not only to give access to filters, heaters, etc., but also to facilitate cleaning of the ducts, which will mostly be necessary in bends. The centrifugal fan acts as a separator, and a cleaning door on its casing should therefore be standard design.

Dampers should be easily accessible, not only for cleaning but for checking and rearranging the blades. I find it most useful to have all small dampers arranged in such a way that they can either be pulled out like drawers or swung out like hinged doors. Large size dampers require operating doors on both sides.

If dust reaches the heating surface, this might cause trouble by decomposition and disagreeable odor. If the heating surface consists of many banks, doors on both ends do not give complete satisfaction. In general, not more than two rows can be reached from each side with special tools. I therefore like to subdivide any multibank heater in units of four banks separated by wide casings with operating doors. This helps not only cleaning, but proves very useful in piping leakage. If such leakage occurs it will not always be possible to repair the heater without much delay. The answer is to have individual shutoff valves on each bank in order to isolate any leaking bank without interrupting the normal working of the plant.

When the air is heated over a considerable range, the inside pressure is lowest where the coldest air enters and higher toward the air outlet. Thus condensate tends to accumulate in banks with lower inside pressure, which even might become flooded and inefficient. This difficulty is overcome by arranging individual traps on each bank. These traps should be assembled as a battery where they can easily be supervised.

Look out that the wheel of the fan can be removed without dismantling heavy duct work. If the wheel has to be removed toward the suction side, an accessible chamber should be arranged there, which might mostly be a mixing chamber with connections for fresh and re-

WHAT INCREASE IN BUSINESS RESULTS FROM AIR CONDITIONING?

You are invited to comment on the following question from "J.O." Suitable comment on this matter will be published, and paid for at regular rates (with additional payment for sketches). Address The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.

"Here's a question that probably can't be answered but I'd be interested in any pertinent comment on the matter that readers of HPAC might be willing to make. I realize that there is little specific data available, but good guesses by informed persons would be of interest to me and, I am sure, to many others.

"This is my question: What percentage increases in business can be expected in a store, a restaurant, and a hotel dining room due to the installation of a good summer air conditioning system?"—J.O.

QUESTION OF THE MONTH

YOU ARE invited to submit a heating, piping, or air conditioning question for publication here. You are also invited to submit answers to previously-published questions from others. Those published are paid for at regular rates. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

circulated air. In this case the automatic dampers form part of the chamber and thus are easily accessible.

When air conditions are controlled by means of dry and wet bulb thermostats, the maintenance of the wet bulb equipment cannot be facilitated too much. Sleeves must be replaced in time, and water must always run without excess. Attach the whole—bulbs and water box—to a hinged door which swings outward and run the overflowing water to a funnel which is well visible, and no trouble will occur in this respect.

After everything possible has been done to ensure that the system works in the predetermined way, an air conditioning plant will still not satisfy everybody concerned. If for instance it serves a store, there are males and females, busy employees and complacent customers. Each group reacts differently to given air conditions. The manager wishes to oblige without complaints being much discussed. He will therefore prefer to have dampers and deflectors in easy reach instead of arguing whether conditions are 100 percent comfortable or not. Zoning alone will not do. It is only human that sometimes doing things in a different way from what the responsible planner has suggested gives satisfaction though it might be wrong. For this reason I reluctantly recommend numerous means of control in the conditioned rooms to be handled by anybody. I know that this method is anything but ideal. But are we?—M. H., consulting engineer.

NEW BOOKS & REPORTS

Explains Fundamentals of Many Types of Controls and Systems

The basic principles of control and the construction and operation of liquid level, pressure, temperature, speed, and humidity indicators and controllers are explained in a practical manual, Instrument and Control Manual for Operating Engineers, by E. W. F. Feller, operating engineer and formerly assistant chief operator, Safe Harbor Water Power Corp.

After the individual units that go to make up a complete control system are described, they are connected together to show how the operation of one unit affects another. A good deal of attention has been given to the operating fundamentals of the various primary elements to give the reader a clear understanding of the physical characteristics. In addition to the various elements and control systems as indicated in the foregoing, the author discusses emergency instruments, feedwater control, hand valves and piping, and traps and condensate systems.

Containing 426 + x pages, this well illustrated text is published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y., and is priced at $6.00.

Develops Slide Rule Calculator for Fluid Flow

A new slide rule for piping engineers and others concerned with industrial piping systems is, in effect, a velocity and pressure drop calculator. It is designed to give two kinds of answers to fluid flow problems; a quick estimate based upon a pipe friction factor of 0.006, and an accurate solution, derived from the estimate, by applying a correction factor to the straight pipe losses.

One part of the rule is devoted to liquids and another to gaseous fluids. The friction factor correction chart and the slide giving fitting and valve losses are common to both types of fluids. Due to compressibility effect, the calculator will not give accurate solutions for gaseous fluids where the pressure drop exceeds 10 to 15 percent of the initial pressure.

The slide rule may be obtained for 50 cents from Tube Turns, Inc., 224 E. Broadway, Louisville 1, Kentucky.

Finds Only Negligible Health Hazards in Arc Welding Steel Ships

Hazards to the health of arc welders engaged in steel ship construction were found to be virtually negligible when adequate ventilation is provided to control the toxic fumes released, according to the report of a study, initiated in 1943, and made by the industrial hygiene division, U. S. Public Health Service in cooperation with the U. S. Maritime Commission and the Navy.

The study, which was made because of the increasing complaints of respiratory illness from shipyard workers, included both environmental and medical surveys. Analyses were made of the fumes and gases contaminating the air of work places in seven Atlantic, Pacific, and Gulf Coast areas. Some 1767 samples of iron and the total fumes were taken, 278 samples for zinc, 25 for lead, and 2019 for the oxides of nitrogen. In general, the concentrations of welding fumes and gases observed were relatively low. Some type of control ventilation was available at all the shipyards studied, and though the ventilation was of varying effectiveness, extreme degrees of atmospheric contamination were infrequent.

During the medical survey, 4650 persons were examined. Some 70 percent of these were shipyard arc welders working with coated electrodes on bare or galvanized steel. Only a few significant clinical symptoms which might be related to occupational exposures were observed. Among these were a respiratory symptom complex, arc welder's siderosis, lowered blood pressure, and welding burns. Detailed studies failed to reveal any marked blood abnormalities among the welders. There was no indication that welding fumes, under the conditions observed, predisposed workers to pulmonary tuberculosis, and gastrointestinal symptoms were infrequent.

Single copies of the report, Health of Arc Welders in Steel Ship Construction—Public Health Bulletin No. 298, may be obtained from the U. S. Public Health Service, Washington 25, D. C. Additional copies may be purchased from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 55 cents each.

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Card No. 70
Job No. ___

___ WATER FEEDER AND LOW WATER CUTOFF: Furnish and install on each the boiler a combination low water cutoff and make up water feeder similar and equal to those manufactured by the _____ _____ _____ Model No. _____ for operation up to ___ psig maximum steam pressure. This unit is to be installed according to the recommendations of the manufacturer and shall be installed with a manually controlled bypass for manual water feeding.

Card No. 71
Job No. ___

(Steam Heating System)

___ AIR VENTS: Vents of the vacuum atmospheric type similar or equal to those manufactured by _____ _____ shall be installed where indicated on the plans.

(Hot Water Heating System)

Vents of the Automatic type for Venting Hot water Heating System Piping similar or equal to those manufactured by the _____ _____ _____ shall be installed where indicated on the plans. A 1/4 in. OD copper tube overflow shall be provided where indicated on the plans on all vents _____ and shall discharge into the most convenient drain on the ground _____.

Vents of the manual Key type for Hot Water Heating System _____ shall be installed as indicated and where shown on the plans.

Card No. 72
Job No. ___

___ OIL PREHEATER: Below-the-waterline oil preheater of adequate size to serve the above specified oil burner and having the ability to raise the temperature of the oil ___ 90 F shall be connected to a header connecting the each boiler section.

Card No. 73
Job No. ___

___ DRAFT CONTROL: Install a ___ in. diameter automatic draft regulator on each the boiler breeching. This These draft regulators shall be similar and equal to those manufactured by _____ _____.

DATA SHEET

Simplified Procedure for SPECIFICATION WRITING

To meet a number of requests from readers for more information about the method described in George W. Campbell's article, A Simplified Procedure for Specification Writing, in the April 1946 HPAC, it was decided to run as a supplement to this article a series of specification cards which are used by the firm of Urdahl and Everetts, consulting engineers.

Several of the cards have been published (and details of their use explained) in the June 1947-March 1948 issues inclusive, more appear this month, and others will follow. These specifications are not to be construed as recommendations to other consultants but to illustrate this card file.

Assume that we have designed a direct fired air conditioning system. We would go to the files and remove card No. A. Looking under paragraph 1, we note general intentions, scope of work, and time of bids. These items should be written on a 5 x 8 in. card or paper and should be given the numbers noted.

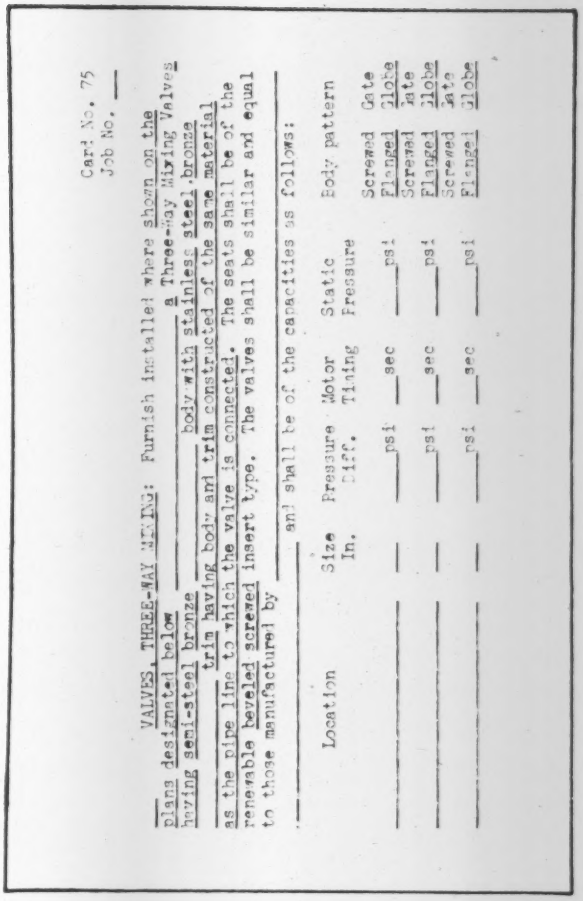
Consulting engineers and architects usually have a permanent set of conditions which they use for the particular locality in which they work, covering such items as checking, definitions, delays and extensions, and accompanying drawings. These are included in paragraphs 2-31 indicated as printed matter; if we do not want to use 30 paragraphs for this material we can easily change the number.

Paragraph 32, work to be done by others, is another paragraph that will have to be written out for each job as every job will be different.

We now have arrived at the part of the system that is a time-saver. We go through the file and pick out all cards having numbers which are listed on Card No. A, following the title of the specification as direct fired air conditioning unit (1), heat exchanger (9), oil burner (11), etc.

We now take the cards and number them. Paragraph 33 of our specification will be given to direct fired air conditioning unit (Card No. 1), paragraph 34 to fuel oil tank (Card No. 23), etc. Should any of the cards now become separated, that loss will be easily detected when the typist starts to type them.

After all the cards have been properly marked for the conditions of the particular job, we turn them over to the typist. After typing, the cards can be stapled together and placed in the job file.

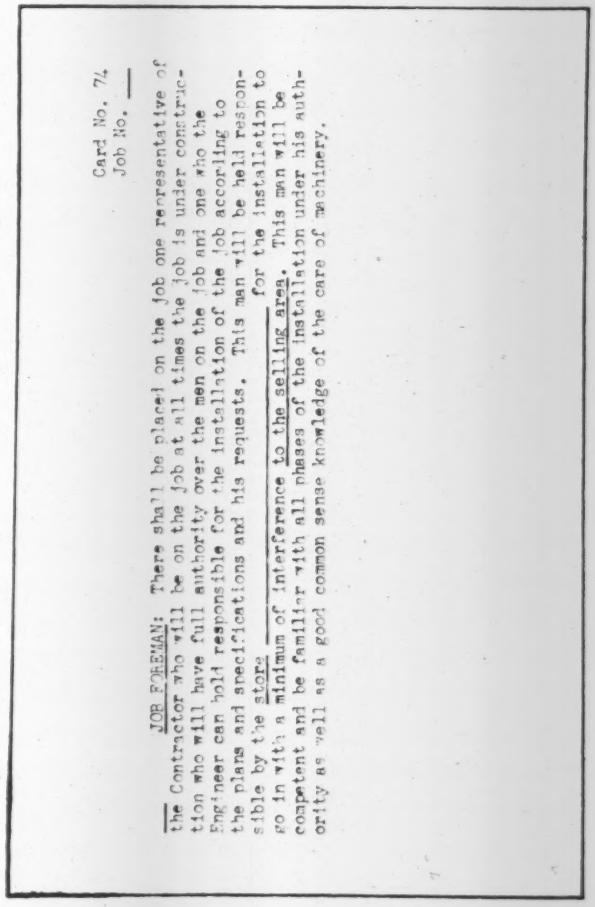


Card No. 75
Job No. ___

VALVES, THREE-WAY MIXING: Furnish installed where shown on the plans designated below _____ a Three-way Mixing Valves having semi-steel bronze _____ body with stainless steel bronze _____ trim having body and trim constructed of the same material as the pipe line to which the valve is connected. The seats shall be of the renewable beveled screwed insert type. The valves shall be similar and equal to those manufactured by _____

_____ and shall be of the capacities as follows:

Location	Size In.	Pressure Diff.	Motor Timing	Static Pressure	Body pattern	
_____	___	____psi	___sec	____psi	Screwed	Gate
_____	___	____psi	___sec	____psi	Flanged	Globe
_____	___	____psi	___sec	____psi	Screwed	Gate
_____	___	____psi	___sec	____psi	Flanged	Globe
_____	___	____psi	___sec	____psi	Screwed	Gate
_____	___	____psi	___sec	____psi	Flanged	Globe



Card No. 74
Job No. ___

JOB FOREMAN: There shall be placed on the job one representative of the Contractor who will be on the job at all times the job is under construction who will have full authority over the men on the job and one who the Engineer can hold responsible for the installation of the job according to the plans and specifications and his requests. This man will be held responsible by the stops _____ for the installation to go in with a minimum of interference to the selling area. This man will be competent and be familiar with all phases of the installation under his authority as well as a good common sense knowledge of the care of machinery.

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Railroad "Weather Unit" Has Own A-C Power

A NEW railroad passenger car carrying its own complete alternating current-operated "weather factory"—entirely independent of the locomotive for its power—soon will be tested on a major railroad, it was reported by H. H. Hanft, transportation engineer of the Westinghouse Electric Corp., at the annual winter meeting of the American Institute of Electrical Engineers, held in Pittsburgh. Mr. Hanft said the car would be subjected to varying climatic conditions of summer, winter, mountain, desert, and northern plain operations, and later would be placed in revenue operations.

The recently-developed unit contains its own a-c power plant and the necessary air conditioning and heating equipment to provide air that will be cooled and dried in summer, and heated in winter. On the car passengers will drink electrically cooled water and will read by flicker-free fluorescent lights.

Power to operate all this apparatus is supplied by a 30 kilovolt-amper diesel driven, alternating current generator installed under the car, Mr. Hanft said. Such a self-contained power plant "permits locomotive power normally diverted to operate car comfort equipment to be applied entirely to its fundamental job of traction." Use of an a-c air conditioning system also permits reducing weight of the railroad car by 3 to 5 tons, or 5 to 8 percent, he said. In the a-c unit, a battery weighing only 700 lb is needed for emergency lighting and for cranking the engine; an additional weight saving of 1800 lb comes from using lighter weight cable and conduit in the a-c car.

Heart of the thermostat-controlled air conditioning installation —which has the same refrigerating effect as the melting of 8 to 9 tons of ice in the car every 24 hr—are the twin 5 hp hermetically sealed compressors carried under the car. Other principal components are the condenser, also mounted under the car, thermostats, and the overhead-mounted evaporator "package" consisting of blowers, evaporator, and electric strip heaters.

The equipment combines to furnish 2400 cfm of conditioned air, with two-thirds of this supply recirculated from the car itself and one-third being make-up air from outside the car.

On cool humid days, below 60 F, excessive moisture in the air is reduced to a comfortable level by action of the car heating system. When outdoor temperature climbs above 60 deg, the first compressor is started automatically and excess water vapor in the car airstream condenses as it comes in contact with the cold evaporator surface, and thus is removed from the car.

On days when the humidity is unusually high and it, rather than the heat, is chiefly responsible for discomfort to passengers, the air must be dropped to a low temperature in order to remove enough moisture. It is then reheated back to a comfortable level.

When temperature inside the car rises above 75 deg, the second compressor goes into operation and operates as long as is necessary to maintain car air at a comfortable 75 deg level. Dehumidification occurs continously as long as either compressor is in operation.

For heating purposes, the car may be equipped with two independent heat sources, relying on steam from the locomotive only in emergencies. Chief source of heat will be 36 gal of "double duty" coolant, which after cooling the engine and absorbing heat in the process is sent to floor heating coils. Afterwards, the coolant is returned to the engine jacket to repeat its cooling-heating cycle.

Additional heat will be supplied by electric strip heaters mounted overhead. They warm air passing into the passenger section and in the duct which introduces outside air. These heaters are essentially strips of steel alloy, heated electrically like the heating element o a toaster and radiating their heat to the surrounding air.

With each car able to provide its own heat, on cold winter days heat requirements no longer will be a limiting factor on the length of trains, Mr. Hanft said.

Before passing through the cooling and dehumidifying coil in the evaporator section, the entire air supply may be electrostatically cleaned. Whether the air has been cooled, heated, or dehumidified, before entering the passenger space it may be exposed to slender germicidal tubes, which radiate ultraviolet rays "deadly to more than 90 per cent of all bacteria found in the air." A newly-designed electric water cooler furnishes a constant supply of 50 deg drinking water, eliminating the need for periodically taking on ice for this purpose.

Another expected advantage of the a-c unit is that it will materially reduce maintenance. The hermetically-sealed compressors eliminate shaft seals, couplings, pulleys, and belts, Mr. Hanft said.

Although an a-c generator mounted in the car is used to operate the equipment in this test car Mr. Hanft said that a larger diesel generator or a steam turbine installed at the train's head-end, on a power car, or on the locomotive tender, could also be used to supply a-c power to an entire train of cars.

"Whichever system is chosen by different railroads to meet their particular operating conditions," the engineer stated, "it appears that cars with alternating current electrical systems, having a source of power other than the locomotive, will play a significant role on American railroads in years to come," he concluded.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Research Aspects of the Heat Pump

By E. N. Kemler*, and N. Kulik**, New York, N. Y.

SUMMARY—The progress to be expected during the next few years in application of the heat pump to year round residential air conditioning will depend directly upon the amount and type of research work that will be conducted. The most important heat pump problem today, insofar as residential applications are concerned, continues to be that of the heat sources, the two basic sources being the atmosphere and the earth.

The authors outline the type of research that should be conducted and discuss the various considerations affecting the problem. A comprehensive tabulation of the various items to be considered in preparing a program of research on the heat pump is included.

During the past few years the heat pump has been brought permanently to the attention of heating and ventilating engineers and to the public as a practical device for residential year round air conditioning. To the public it represents a practical means of obtaining in the home both heating and cooling together with all of the benefits which a year round air conditioning system can give. From the standpoint of the electric utilities it represents a potential new source of electric load equal to the present residential load. To the heating and ventilating industry it likewise represents a potentially expanded market.

The heat pump is, from a thermodynamic point of view, a new application of old refrigeration cycles. Considerable ingenuity was necessary, however, in adapting these basic cycles to the production of a packaged type of equipment which would be suitable for home and commercial installations. The development of the residential type heat pump to its present status has been closely tied in with the research work of the heat pump manufacturers. The device as offered today gives an automatic type of heating and cooling system which has not heretofore been possible. It is to be expected that the heat pump will have imposed on it more and more stringent performance requirements, in regard to which a considerable portion of the research work of the future heat pump will be directed. This work involves manufacturers of heat pumps, the utility companies which serve them, the auxiliary equipment manufacturers, and the technical societies.

The most important heat pump problem today insofar as residential applications are concerned continues to be that of heat sources. Looking at the problem from a general application viewpoint there are two basic heat sources which could be developed for more or less universal application of the heat pump. These are the atmosphere and the earth. Inasmuch as heat pump performance depends on the temperature range through which heat is to be pumped, it is obvious that air by itself as a heat source is not particularly attractive for residential use in regions where outside air temperatures are appreciably below freezing. Mechanical difficulties due to frost formation, complex controls, and other operating problems also make air as a heat source unattractive under these conditions but its universal availability and general accessibility make it worth further investigation.

The earth as a heat source offers

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Presented at the 54th Annual Meeting of the American Society of Heating and Ventilating Engineers, New York, N. Y., February, 1948.

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many advantages because of the generally uniform temperature at which it is available even in northern areas. To date its disadvantages are the cost and difficulty of installing sufficient heat transfer surface to obtain good performance. Research on methods of obtaining heat from the earth, theoretical investigation of heat flow under various types of conditions, experimental information on the various types of heat sources which have been proposed, and finally an investigation of special heat sources, represent some of the more important problems which need to be studied. The general problem of heat sources for the heat pump is complicated in part by the fact that there exist so many possibilities. A general view of this field can be had from Table 1, prepared by W. F. Friend.

Heat Source Research Concerns User, Manufacturer, Utility

The heat source is, of course, of great interest to the user because of the fact that the cost of the heat source is a considerable portion of the heat pump installation whether it be an earth or air type unit. As with similar devices the user does not finance directly the research necessary to develop the idea to a practical stage. Usually someone who can profit later through manufacturing or sales advantages, finances the development in the hope of future returns. The user must recognize this when he purchases new or improved devices. Since the heat source is an application problem, it is a problem for both the utilities and manufacturers to investigate. Since the utilities have potentially a large market in the heat pump in the form of electric energy sales and can profit from all uses, they are one possible source of support for heat source research. The user must however expect to pay for such research indirectly through his electrical rates. While such expense means a very small increase in electrical rates, the improved performance which can result from such work can result eventually in lower total electrical cost to the user.

Table 1—Outline for Research on Earth as Heat Source in Connection with Development of Electric Heat Pump for Residential Service[a]

A—Geological Strata to Be Investigated
- 1—Classification by states and regions
  - *a*—Loam
  - *b*—Silt
  - *c*—Sand
  - *d*—Gravel
  - *e*—Clay
  - *f*—Gumbo
  - *g*—Caliche
  - *h*—Moraine (boulders)
  - *i*—Hard pan
  - *j*—Shale
  - *k*—Rock
    - Gneiss
    - Granite
    - Sandstone
    - Other
- 2—Data to be obtained
  - *a*—General description
  - *b*—Mechanical analysis
    - Particle size
    - Hardness
    - Angle of repose
  - *c*—Chemical composition
  - *d*—Density, dry and wet basis
  - *e*—Porosity
  - *f*—Specific heat
  - *g*—Latent heat
  - *h*—Thermal conductivity
  - *i*—Effect of freezing on *d*, *f*, *h*
- 3—Soil sampling and testing
  - *a*—Size of samples needed
  - *b*—Field test methods
  - *c*—Laboratory test methods

B—Groundwater Occurrence
- 1—Height of water table, referred to ground elevation and sea-level
  - *a*—Normal
  - *b*—Seasonal fluctuations
- 2—Rate of subsidence after rain or water injection
- 3—Natural water circulation or movement
  - *a*—Horizontally
  - *b*—Vertically
- 4—Water content or percentage saturation of earth

C—Natural Vertical Temperature Gradient in Earth at Selected Geographic Locations
- 1—In winter months
  - *a*—Data to be obtained for kinds of earth listed under A-1
  - *b*—Effect of water content on depth-temperature relation
- 2—In summer months
  - —Subdivisions as above for 1

D—Natural Cyclic Temperature Variations of Earth
- 1—Daily
- 2—Periodic (between successive cold or hot spells)
- 3—Seasonal (cumulative effect)
- 4—Yearly (influence of seasonal reversal)

E—Factors Affecting Earth Temperature and Cyclic Variation
- 1—Ambient air temperature
- 2—Solar and sky heat radiation
- 3—Re-radiation (upward heat dissipation)
- 4—Precipitation
  - *a*—Dew
  - *b*—Rain
  - *c*—Snow
- 5—Evaporation
- 6—Wind
- 7—Conduction from and to underlying substratum

F—Effect of Top Surface
- 1—On solar heat absorption
  - *a*—Vegetation (grass, shrubbery, trees)
  - *b*—Autumn leaf accumulation
  - *c*—Bare ground
  - *d*—Pavement and sidewalks
  - *e*—Frost penetration
  - *f*—Snow cover
  - *g*—Roofing felt or other barrier
- 2—On re-radiation (upward heat dissipation)
  - —Subdivisions as above for 1

G—Influence on Vegetation Growth of Seasonal Soil Temperature Changes Due to Heat-Pump Operation
- 1—Kind of vegetation
  - *a*—Lawns, ornamental shrubbery
  - *b*—Flower gardens
  - *c*—Vegetable gardens
  - *d*—Orchards
- 2—Retardation in spring, by sub-soil chilling
- 3—Stimulation in summer, by sub-soil heating
- 4—Prolonged growing season in autumn

H—Relative effect of Heat Input and Withdrawal, on Earth Temperature and Gradients
- 1—Determination as to whether tests can be confined to heat input and translated by calculation for heat withdrawal, or whether separate tests required for determining heat *reservoir* capacity and temperature gradients

I—Temperature Gradient in Earth With Operation of Heat Pump
- 1—Vertically, as affected by
  - *a*—Location, arrangement and size of heat-pickup device
  - *b*—Rate of heat input or withdrawal by heat pump
  - *c*—Total cumulative heat input or withdrawal
  - *d*—Kind of soil
  - *e*—Water-table elevation
  - *f*—Water content of stratum
  - *g*—Top surface conditions
- 2—Horizontally
  - —Subdivisions as above for 1

[a]Compiled by W. F. Friend, Ebasco Services, Inc.

Table 1—*(Concluded)* **Outline for Research on Earth as Heat Source in Connection with Development of Electric Heat Pump for Residential Service***

J—Methods Available for Producing Vertical Holes
- 1—Well drilling rigs
  - *a*—Impact
  - *b*—Rotary
- 2—Well digging tools
- 3—Post hole diggers for fence posts and wood poles
  - *a*—Manual
  - *b*—Power driven
- 4—Caisson setting equipment

K—Methods for Placing Vertical Pipes Without Holes
- 1—Well-point driving
  - *a*—For water-supply systems
  - *b*—For excavation unwatering
- 2—Electric ground-rod placing
- 3—Pile-driving rigs
  - *a*—Wood and concrete piles for foundations
  - *b*—Sheet piling for trenches, coffer dams
- 4—Water jetting method for sinking wood and concrete piles

L—Methods for Trench Excavation
- 1—Plows for placing parkway electric and telephone cable
- 2—Trench excavating machines

M—Methods for Placing Horizontal Pipes Without Trenches
- 1—Hydraulic jacking devices for gas and water pipes
- 2—Auger operated by compressed air
- 3—Jetting by compressed air and water
- 4—Procedure for *gallery* water header system

N—Material and Methods for Backfill in Holes or Trenches
- 1—Soil removed from excavation
- 2—Other soil selected for conductivity
- 3—Metallic admixtures
- 4—Concrete, bitumastic compounds, etc.
- 5—Methods for getting high thermal conductivity
  - *a*—Puddling with water
  - *b*—Tamping by hand tools
  - *c*—Compacting by vibrators
  - *d*—Impacting devices applied on pipes

O—Provision for Maintaining High Thermal Conductivity in Earth
- 1—Water application on surface or in open trenches
- 2—Water-injection pipes buried in earth
- 3—Other methods proposed

P—Heat Pickup and Disposal Pipes and Devices Installed in Earth
- 1—Type of application
  - *a*—For indirect heat-transfer fluid circulation
  - *b*—For direct refrigerant use
    - Winter service as evaporator
    - Summer service as condenser
- 2—Kind of device
  - *a*—Plain pipe or tube
  - *b*—Serpentine pattern tube
  - *c*—Spiral coil
  - *d*—Concentric tubes
  - *e*—Flat plate
- 3—Position of device
  - *a*—Vertical
  - *b*—Horizontal
  - *c*—Inclined, looped, etc.
- 4—Methods for improving heat transfer between earth and metal
  - *a*—Fins, ribs, webs, collars, studs, etc. on exterior of tubes
  - *b*—Other methods, supplementary to subdivisions N, O above
- 5—Minimizing amount of fluid or refrigerant
- 6—Provision for equalizing of flow in multiple tubes
- 7—Pressure-drop reduction for power economy

Q—Protection of Buried Metal Parts Against External Corrosion
- 1—Metallic coating or plating
- 2—Paint or composition coating
- 3—Cathodic (electric) protection method

R—Heat Transfer Fluids for Indirect Method
- 1—Physical and chemical properties required
- 2—Fluids available
  - *a*—Antifreeze solutions for automotive vehicles
    - Ethylene glycol (Prestone)
    - Glycerine
    - Alcohol
  - *b*—Brine for ice—and cold-storage plants
  - *c*—Other thermal-process fluids
- 3—Corrosion inhibitors

S—Construction Cost Data and Estimates
- 1—Installation methods
  - *a*—For subdivisions J to O
- 2—Heat-pickup devices
  - *a*—For subdivisions P to R

T—Performance and Comparative Economics of Methods and Devices J to R
- 1—Coefficient of performance for heating
- 2—Power kw per ton of refrigeration for cooling
- 3—Annual energy consumptions
  - *a*—For heating
  - *b*—For cooling
- 4—Annual cost, including operating expense and fixed charges

*Compiled by W. F. Friend, Ebasco Services, Inc.

JOURNAL SECTION

Problems dealing with controls are basically the concern of accessory manufacturers although they are also of considerable interest to the heat pump manufacturers because they influence both the complexity and performance of their equipment. Controls are of interest to the user because they determine the degree of reliability of automatic operation and cost of operation of his equipment. In some respects controls are of considerable importance to the utilities because they influence the type of load and the demands which it makes on power supply. Of primary importance in this respect are motor characteristics. Motor efficiency is of considerable importance in the heat pump operation inasmuch as the useful output is approximately three or four times the motor input to the system. An increase of 5 percent in electric motor efficiency would mean for example an increase from 4 to 4.2 in the coefficient of performance.

Another accessory problem is that of improvement in multiple way valves. Fig. 1 shows a simple heat pump system utilizing four valves for conversion from heating to cooling. By the use of a single solenoid operated four-way valve, automatic operation could be obtained as is indicated in Fig. 2. Other problems along these lines are improvement of solenoid valves, development of special refrigerants, and production of low cost special type accessories such as low cost electrostatic dust precipitators and germicidal lamps. Since individual manufacturers can profit through development of special products of this type on which they can obtain patent protection, they can be depended on to develop these accessories for the heat pump. Here again; however, the user, utilities and manufacturers need to follow these developments closely and in many cases participate in them. For example, certain types of heat pump installations can use multiple speed motors to advantage. Present multi-speed motors give a very low power factor when operating at slow speed and since a majority of the operation would be at this slow

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speed, it is important to the utilities to follow such developments. If motors having these characteristics are imposed on their systems, an undesirable load would result and would be reflected in higher electric energy cost to the consumer.

Heat Pump Poses Application Problems

Any new device such as the heat pump introduces numerous application problems. First among these application problems is that of studying comfort requirements in terms of heat pump operation. Some of the requirements of the heat pump, insofar as heating is concerned, are somewhat similar to ordinary warm air or radiant heating systems. The fact that the heat pump gives better performance as the discharge temperature becomes lower makes desirable an investigation of duct and outlet design of a type which will give satisfactory comfort with lowest possible circulating air temperature. The limiting or minimum requirements for satisfactory home cooling have, of course, been subject to little investigation, and it is probable that a considerable amount of study will be necessary on this subject. All of these requirements will become increasingly important as the heat pump moves from a luxury to a necessity item.

Among other application problems which deserve further study are the analysis of air distribution systems for heating and cooling, determination of noise and vibration limitations, insulation requirements, development of design procedures, and investigation of possibilities of heat pump applications to existing homes. The design and application of heating systems regardless of type will receive more attention in the future because of both the increased cost of such equipment and the increased operating expenses. General research conducted to determine temperature and air velocity distributions in residences under various conditions such as are applicable to heating and cooling systems can be adapted, at least in part, to heat pump installations. Since much of this work is of general interest to the heating and ventilating and air conditioning industries, a considerable portion of it would probably be carried out in connection with organizations such as ASHVE, *ASRE*, and the *Edison Electric Institute*.

Oversizing of the heat pump, in addition to increasing the cost to the user, imposes severe power requirements on the utility. While the operating time is reduced by installing oversized equipment, the reduction in load factor, together with increase in demand, would result in higher energy charges to the user. Furthermore these increased peak demands can impose severe operating requirements on the utilities. Since the heat source is also a problem, oversizing increases the requirements on the heat source system.

Some of the technical problems involved in connection with the overall heat pump development program involve the study of overall possibilities of heat pumps, study of humidity control, investigation of various possible heat pump cycles, investigation of combination units for heating, refrigeration, hot water heating, etc., and investigation of possibilities of energy storage and its effects on heat pump performances. These problems are largely technical and can only be solved by planned research programs. It would be particularly interesting, for example, through the construction of idealized types of units obviously not adaptable for commercial development, to see what the limitations are in connection with the use of the heat pump insofar as coefficients of performance are concerned. Because of the many possibilities of heat pump systems, this general information would be very helpful in the development of specialized units to fulfill the requirements of residential or commercial specifications.

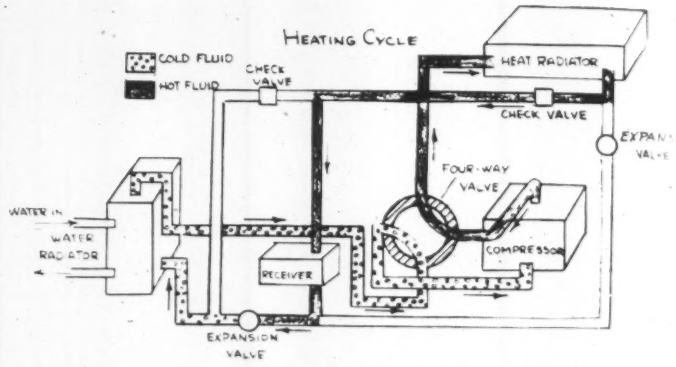

Fig. 2—Heat pump system employing automatic 4-way valve for change-over

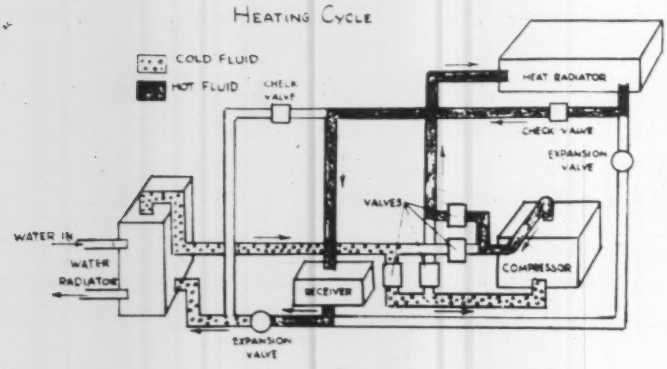

Fig. 1 — Heat pump system employing four valves for change-over

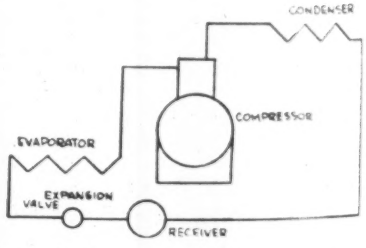

Fig. 3—Simple vapor compression refrigeration cycle for heat pump

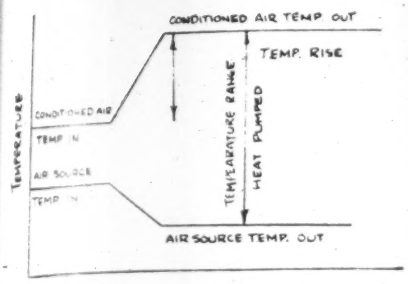

Fig. 4—Heat exchange in single-stage cycle

Compressor Staging Should Be Studied

One of the technical studies which needs to be undertaken is a theoretical investigation of possible heat pump cycles. To date most work on the heat pump has considered only the simple vapor compression refrigeration cycle as indicated by Figs. 3 and 4. One possibility for improved performance which will undoubtedly be investigated is that of staging. Staging, as shown in Figs. 5 and 6 would reduce the amount of work required and hence result in improved performance. Basically, staging could be developed so that the heat would be pumped only to the temperature used, whereas in the simple system of Figs. 3 and 4 it is pumped to the highest temperature needed. This particular example is used to indicate the need for further work in the general field of analysis of thermodynamic cycles for heat pump systems.

Humidity control is a particularly important problem in connection with summer cooling and one which deserves a great deal of study. In some areas humidity control alone might be sufficient for summer space conditioning. Dehumidification by refrigeration is, in a great number of cases, the most economical means of reducing humidity. The heat pump would therefore appear to be the practical means of accomplishing summer air conditioning and humidity control. To properly adapt the heat pump for this purpose requires more detailed information on the requirements.

Many possible combinations of the heat pump and other devices have been suggested to obtain a higher load factor, both from the standpoint of the user and the utilities. The possibilities of combining the heat pump for home conditioning, hot water heating, and supplying domestic refrigeration probably deserve some consideration. Examples of combining refrigeration and hot water heating have been reported. A combination of the heat pump with deep freeze, domestic refrigeration, and hot water functions is a possibility. Until a better idea, however, is had as to the minimum requirements in each of these fields and until the present demand has been partially met it is believed that the heat pump development should proceed unhampered by these accessory requirements. Because of the special requirements of these appliances it is doubtful if their combination with a space heating unit can be economically justified.

Theoretically the utilization of energy storage in connection with heat pump development is possible, giving the advantage of smaller size equipment. This will simplify the heat source design problem and improve the load factor and performance of the equipment. Most of these problems are those of the manufacturer and the utility.

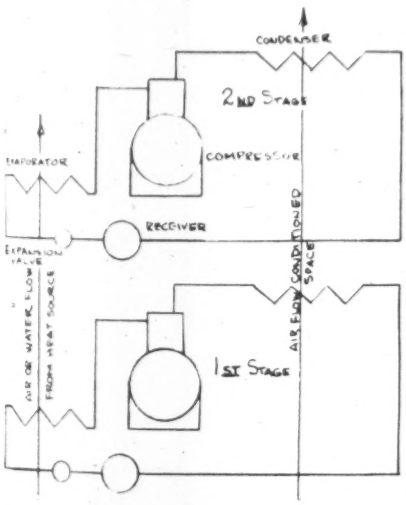

Fig. 5—Two-stage vapor compression refrigeration cycle for heat pump

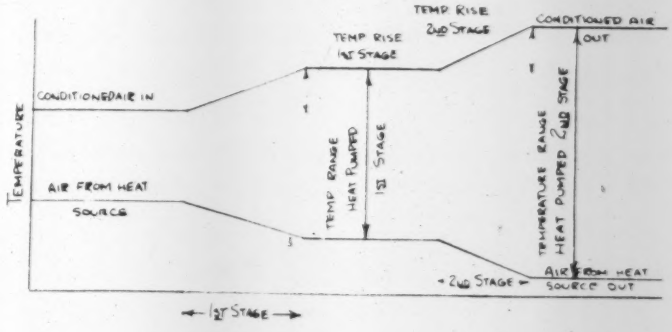

Fig. 6—Heat exchange in two-stage cycle

There are a number of miscellaneous problems which arise in connection with the development of the heat pump that also deserve consideration. Among these is a problem of particular importance to the ASHVE, namely that of studying methods of determining heating requirements for homes using a heat pump. A prominent member of the ASHVE recently stated that the design procedure as outlined in THE GUIDE would result in a calculated heating load several times that required of the heat pump. Manufacturers of equipment have claimed that elimination of the necessity to furnish combustion air together with losses up a chimney would reduce heating requirements considerably. There is no doubt that these factors need to be considered and will need to be investigated.

Since heat pumps are so critically tied up with heat sources, any means that would reduce the maximum requirements would result in quite an appreciable saving in cost, both initial and operating. The many savings claimed for radiant heating indicate that an investigation of the possibilities of the heat pump in radiant heating installations would be desirable. Because of the low temperatures required in the case of water systems, the heat pump has definite possibilities in this type of application.

Another problem, namely that of home designs to take advantage of the heat pump, deserves very serious study on the part of those groups serving the building industry and public. Because the heat pump offers for the first time a complete year round service, it is possible for the first time to bring about radical

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changes in home design. Chimneys can be eliminated, windows as such can be eliminated and other changes can be made to effect a reduction in construction costs comparable in magnitude to the cost of the heat pump installation.

Future Progress Depends on Research Work

Table 2 lists some of the more important problems on which research will need to be conducted before the heat pump has been developed to its fullest extent. The development of the heat pump is complicated somewhat by the many possibilities that exist in almost every phase of its application. In order to be able to cover the general field, it is important that unnecessary duplication be eliminated and that the more important problems be investigated first. This paper has not attempted to cover the entire field but only the more important phases concerned with residential applications. Much progress has been made to date but the progress to be expected during the next few years will depend directly on the amount and type of research work that will be conducted.

Table 2—Residential Heat Pump Problems Needing General Stu

I. Heat Source
a. Adaptation of air as heat source.
b. Development of earth as heat source.
c. Collection of general information on heat sources.
d. Methods of tapping the earth for heat.
e. Methods of maintaining high thermal conductivity with earth.
f. Analytical studies of heat flow.
g. Design information on heat source equipment.
h. Study of special heat sources.
II. Application Problems
a. Study of comfort requirements in terms of heat pump operation.
b. Analysis of air distribution systems.
c. Determination of noise and vibration requirements.
d. Collection of installation design information.
e. Working out of design procedure.
f. Collection of performance data.
g. Study of service problems.
h. Possibilities of applying heat pumps to existing homes.
III. Technical Details
a. Improvement of motor characteristics.
b. Developement of multiple way valves for switching.
c. Improvement of solenoid valves.
d. Development of improved defrosting methods.
e. Development of special refrigerants.
f. Study of electrostatic dust precipitators.
g. Study of germicidal lamps.
IV. Miscellaneous General Problems
a. Study of extreme possibilities of space heating units.
b. Analysis in more detail of hot water heating features.
c. Methods of determining heating requirements.
d. Radiant heating posssibilities using heat pump.
e. Humidity control problems.
f. Home designs to take advantage of heat pump.
g. Possibilities of combination units.
h. Analyze effect of storage on performance.
i. Thermodynamic analysis of heat pump cycles.
V. Investigation of Gas, Oil and Coal as Primary Energy Sources

CONTROL OF PANEL HEATING AND COOLING INVESTIGATION

A comprehensive investigation on the Control of Panel Heating and Cooling Systems has been approved by the Committee on Research at its meeting in New York, according to an announcement made by L. N. Hunter, chairman. He stated that this action of the committee activates the third phase of the overall research program on Panel Heating and Cooling, under the direction of G. D. Winans, Detroit, Research Technical Committee chairman.

The Committee has previously approved projects involving heat transfer within and behind the panel and heat transfer between the panel surface and the space.

The complexity of the approved studies on Panel Heating and Cooling has demanded great care in planning. The many factors affecting this type of heat transfer have been given serious consideration. Every effort has been made to maintain control over these factors so that the effect of each may be determined with a reasonable degree of accuracy. Without this care the resulting engineering data would be open to question.

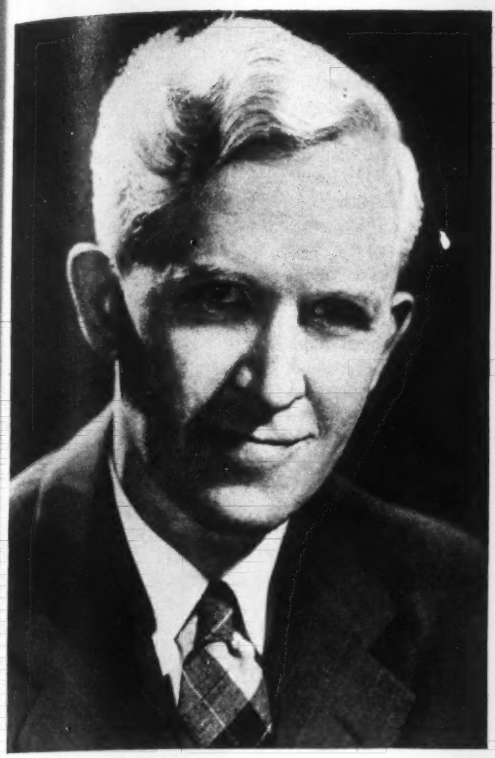
This action by the Committee on Research is the result of recommendations made by Group D of the Technical Advisory Committee on Panel Heating and Cooling at its last meeting in Chicago. J. S. Locke, chairman of Group D, stated that the objective of his group was *to determine what controls are necessary for comfort regulation of panel heating and cooling systems.*

To this end recommendations made by Group D include field surveys and tests in various types of buildings, with analytical investigations undertaken concurrently. Experimental studies are to include hot water, warm air, and electricity as heating media. These investigations will involve various combinations of heavy and light panels and heavy and light building construction with both large and small glass areas. Control procedure will include *on-off* and *continuous operation* with inside and outside thermostats used singly and in combination. Night set-back and other operational details as may prove to be desirable will also be studied.

APPOINTMENT OF DR. A. L. CORBMAN

Effective January 15, 1948, Dr. A. L. Corbman has been appointed director of administration and research, Corbman Brothers, Philadelphia, Pa. Prior to his present appointment Dr. Corbman was director, dental division, Massachusetts Department of Public Health, Boston, Mass. Dr. Corbman's particular interest lies in the field of convection heating and its bearing on the physiology of the body.

A fellow of the *American Public Health Association*, Dr. Corbman has participated in various national committees sponsoring child health. In addition to his membership in the ASHVE, Dr. Corbman also holds membership in the *American Association for the Advancement of Science.*



G. L. Tuve
Cleveland, Ohio
President

Proceedings of the 54th Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Hotel Commodore New York, N. Y.
February 2-5, 1948

THE 54th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, held at the Hotel Commodore, New York, N. Y., February 2-5, 1948, attracted a heavy attendance of the membership—one of six, or 17 percent of all members on the rolls.

First Session—Monday, February 2, 9:30 a.m.

At the first session the reports of the officers were presented.

President's Report for 1947

The AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is outstanding for the participation of its members. At the 53rd Annual Meeting held in Cleveland, the number of registrations was approximately 2000. Of these about 1100 were members of the Society. This means that approximately one of every four members of the Society was in attendance. For an organization with thirty-nine chapters reaching from Massachusetts to California and from Washington to Georgia this is a phenomenal showing. Further, the members do not come just to listen; they participate. The 14 technical advisory committees of the Committee on Research number more than 200 members. Five of the Committees of the Society are restricted to members of the Council and number three members each. Supplementing these, however, are a number of Society committees in which the membership runs to as high as a dozen in cases where a committee of this size is indicated and can be efficient. There is a tendency in national meetings to overlook the extent to which members participate in the work of the chapters. A picture of this participation is given this year in the reports of the Chapter Relations Committee and the different subjects covered in its communications to chapters. Local committees probably involve from a quarter to a half of the membership of the chapter. These men are engaged in planning programs, arranging meetings, nominating new members, providing publicity, supporting research projects, and even publishing chapter periodicals.

In reporting therefore on the activities of the Society, the President does not mean to slight those of chapters and of far-flung committees when he calls specific attention to the committees and groups which deal primarily with the central affairs of the Society.

Society Government

A President deals first with the Council. This group is the governing body of the Society—its board of directors. It meets at least five times each year. These meetings occur quarterly: one is at the time of the Semi-Annual Meeting, and two occur between the Annual and Semi-Annual Meetings, one in the spring and one in the fall. At the time of the Annual Meeting, two meetings of Council are held: one for the outgoing Council, one for the incoming Council. Thus each President serves as chairman at five meetings.

One has only to be the President to discover how rapidly his term passes and how short a time there is in which to carry forward even the few projects which it may be desirable for him to undertake. He should and usually does name all committees at the first Council Meeting of the year held at the close of the Annual Meeting and on the same day on which he is inaugurated as President. This means that for several months before his election he must assume that he is to be President and proceed with the investigation of qualifications of persons for the committee appointments to which they are named. It is general experience that the activities of the year are about half over for the incumbent when the Second Council Meeting is held in the spring. Thereafter it is usually too late to start any major activities without assuming their continuance by the next President. This is mentioned to indicate how vital a quick start is.

There is a basic difference between a Council Meeting and that of a board of directors of a corporation. Seldom in a board of directors meeting is any important business transacted which has not originated through the officers of the corporation and particularly through its President. In the Council, this is far from the case. Those who read the President's message on Society progress issued on December 1, in which items

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coming before the meeting of Council on November 10 were reviewed, can have some impression of the source of the business of the Society.

Many Technical Papers Presented

For example, the rapid growth of the Society is reflected in a trend toward increasing numbers of papers. Also the development of the Laboratory with a substantial permanent staff and a budget, which for the year 1948 will approximate $100,000, call for re-examination of publication policy. It is apparent, for example, that papers of many types and of different degrees of significance and utility will be presented. A special committee under Dean L. E. Seeley has been studying the problem of publication policies and their administration. This committee follows a committee of 1946 dealing with the same question. Many of the problems came to Dean Seeley's committee from the Committee on Research, and this committee in turn received them from cooperating institutions, from members and from the staff of the Laboratory. On the side of the New York office, the Secretary, as general editor of Society publications, is in direct administrative touch with the publisher of the JOURNAL of the Society, with the Publication Committee, and with the authors of papers in the problems of editing. He is ably assisted by the Technical Secretary in these matters. As a result of committee studies, four types of publication have been authorized. Furthermore with a rapidly increasing number of papers presented, a fairly critical selective policy will be necessary to keep the volume of papers within the resources and desirable limits of Society publication. Special study of costs, of sale of reprints at modest prices, and procedure for suggesting modifications to authors where these seem to the Publication Committee or the Committee on Research to promise greater usefulness of the paper or papers presented are delicate problems. I am happy to report substantial progress toward agreement on some of the more difficult questions. The subject, however, is far from a closed one. The problems are too complex for quick analysis and quick determination of procedure. Substantial progress has been made and further development may be expected.

Committee Work

At each meeting of Council the several standing committees of the Council report. Naturally, the Finance Committee is concerned, first of all, with the degree to which the forecast of operations represented by the Society's budget is being realized during the year. In this connection it is important to note that Society funds come only in part from dues. There is an income of varying amount from year to year from the publication of THE HEATING, VENTILATING, AIR CONDITIONING GUIDE. There is income specifically allotted to research from the Exposition when held and the allocation of this to the Committee on Research becomes a duty of the Council. There is further income from the publication contract whereby the Society receives money instead of expending it for the publication of its proceedings. Finally, of course, there are the dues and initiation fees from members. The total income and total expenditures are estimated and decided in the form of a budget at the Fall Meeting of each year. During the year the validity of these estimates must be checked constantly by the Finance Committee. Furthermore, the problems of employment of a staff in the New York office particularly and of the determination of standards for the staff in the Laboratory are constantly under review by the Finance Committee. The budget for 1948 was adopted at the November 1947 meeting, but one or two problems in it have been left for determination and report by the Finance Committee at the closing meeting of Council at this Annual Meeting.

During the year the problem of revision of the Constitution and By-Laws has been carried forward by the Committee of that name. Owing to the death of Past-President W. T. Jones, the chairmanship was assumed by Past-President S. H. Downs and the work vigorously prosecuted. The task is not an easy one as you will discover through the Committee's reports. It is complicated by the fact that the Council is the governing body of the Society, that the Charter must conform to the laws of the State of New York, that the By-Laws must regulate the activities of the Society, that sufficient flexibility must be left to the Council as a governing body and to the membership to carry out the major purposes of the Society without endangering the stability and the continuity of purpose which the membership earnestly desires to have protected. A delicate balance is necessary. In the opinion of the President, the work of the Society is carried on with substantial freedom under the Constitution and By-Laws. Changes of any substantial character in the policies of the Society and in its mode of operation properly require approval of Council or of the Society itself. It is the President's belief that the requirements are in general sound but that the time intervals required for some of these changes are excessive. It will be recalled that a lapse of time of over two years was required by the Society in order fully to authorize the use of some of its own funds for the purchase of its Laboratory. Most, if not all approvals required are logical. The total number, however, constitutes a very serious impediment to rapid action even when the Society is unified in its desire and intentions. Problems of this type are necessarily complex. The Committee on Constitution and By-Laws has met the issue in some cases by specifying more carefully than in the past the jurisdiction of certain committees, thereby giving them greater authority to proceed. This is, for example, the case with the Meetings Committee, which in the future will have larger authority in the organization of meetings and the necessary steps to make meetings a success. The importance of having the Society enter new areas and use new techniques to cope with the increasing complexity of the field, with the changing character of membership, and with the increased importance of research in the industry is, I believe, evident. Whether the Society will require further flexibility carried into its Constitution and By-Laws will be revealed by time. It is the President's belief that substantial progress has been made but that further changes may prove necessary before the ideal condition of balance between stability and flexibility is obtained.

During the year the Council gave careful consideration to the problem of expositions. As a result the exposition for 1949 has been scheduled for Chicago, and a continuing contract has been worked out with the International Exposition Company, of which C. F. Roth is President, to run over a period of ten years. Members should be proud of the admirable record made in expositions held in the past. They should also recognize the key position of this Society in the field of air conditioning and the implication thereby that as a Society it should devote itself to general expositions representing all phases and should take leadership in holding these at such intervals as good judgment and rapidity of development indicate. Efforts are being made to adjust the schedule of exhibitions held by the Society with those of other interested organizations and progress has been made.

Pension Fund

This meeting is the first at which the Society takes note of the Trustees of the pension fund. The creation of this group of three society members for the administration of the pension system recently adopted marks the culmination of more than three years study of this complex and important problem. It became apparent that the Society in its professional and top managerial posts was in competition with universities, research agencies, and other organizations which have adopted pension plans. The Society's structure and problems are different, of course, from a number of these but greatly resemble others. For two years the question of pensions was studied by the Finance Committee. During the year 1947 it was brought to a head by a Special Council Committee under the chair-

manship of John F. Collins and the system put in operation. In brief, permanent professional members of the laboratory staff and of the Society contribute toward the purchase of a retirement pension, their contributions being substantially matched by the Society. The amount of salary deduction for this purpose is of the order of five percent, but because of differing ages and therefore different periods of service there is some variation. The system is believed to be a good one and both the Society and its staff have their contributions to the system well safeguarded by the provisions. Any member interested in the details may consult the Secretary for additional information. It is too complex to attempt to outline here.

Research Fund Raising

The President reports with satisfaction the accomplishments of several special committees which were appointed by the Council on his recommendation early in the year. These are: *Committee on Promotion of Research*, with John Haines chairman. For more than a quarter of a century the Society has been conducting research and has received support for the research in part from the industry and from agencies who found such investment desirable. With the expanded program of the present and with an effort to have a substantial portion of the research contribute more directly to the general needs of the industry, it became desirable to have a committee which would devote itself to ascertaining the best means of correlating the Laboratory with the industry and of securing the financial participation of industry in projects of common concern. Further, there are a number of members and organizations who do not have projects requiring immediate and specific investigation by the Laboratory but who recognize the desirability of having the Laboratory carry on its investigations from year to year and who desire to share in the expense. The Committee concluded that one important step in developing a better understanding and in securing needed financial support would be to distribute to industry and to the membership a booklet describing the Laboratory and its work. This has been done. In developing the booklet and in furthering the work of Chairman Haines' committee, the Assistant to the President, Clyde A. McKeeman, has been a key figure.

About two years ago the Society decided that the administration of the program of research should as always be directed by the Committee on Research; however, the obtaining of support should be a general Society function under the direction of the Society's administration and the Council. In order to prosecute vigorously the determination of programs of research of interest to industry and to arrange the conferences necessary to put them into effect, the Society in 1946 named an Assistant to the President. Each month a detailed report is made to the President about conferences with officers of associations in our field or of those having an interest in our field and conferences at the Laboratory for the purpose of reviewing projected programs, determining of budgets, and soliciting necessary support. During the past year contributions received, largely by reason of the work of this officer, have reached approximately $30,000. For the coming year it is expected that this total will increase by at least fifty per cent.

It is hard for any member of the Society who does not know the details of these operations to understand the number of conferences necessary in the process of evolving a project which is of general interest and concern to the industry; not a specific project for a company and yet one which has early utility. In order to preserve the neutral position of the Society and to conform to the requirements of the Constitution and By-Laws restricting activities with reference to specific appliances, the Society has found it increasingly desirable to deal with associations and groups of manufacturers. One of the most successful and promising of these arrangements is with the leaders in the glass industry. Comparable programs are under consideration in two or three other important areas. Present arrangements seem sound. They have been in effect for something less than two years and the results already are good. It should be recognized by all concerned that the Assistant to the President is not just an officer who represents the Society in securing support for its research. He must also represent the Society in directing this support toward the advancement of the industry and of the science, and to this end must constantly serve as an interpreter of the purposes of the Society itself.

Reference has been made to the financing of the research program of the Society, to the purchase of the Laboratory and to the provision of retirement pensions for the permanent Laboratory staff. These are all important items but important primarily to permit the kind of research program which will be worthy of the Society. Shortly, if not immediately, the Society's research in certain fields should be developed to be the most advanced, incisive, and promising of any research programs in the field. This will not be true in all divisions, but there should be a few general areas in which the Society's work is pre-eminent. A good beginning has been made. The Director and his staff have laid excellent foundations. The past of the Society throws in review the pioneer work in the field of the comfort chart and physiological reaction, work which has met the test of time. Refinements are doubtless needed, but the basic character of the work stands as a monument to the concept of research of the leaders of the Society of twenty years ago.

In the intervening years the necessity of stronger and larger teams for investigation of wide areas has increased and the complexity and cost of equipment have risen. In the opinion of the President the leadership of the Society in certain areas of research, that is to say national and international leadership, will probably follow the establishment of a number of firm areas of research of moderately advanced character; these may include sponsored projects with prospects of early utility to the profession and to industry. Thus, projects of the nature of the glass investigation, of panel heating and the like, should lead one by one to the laying of a broad foundation out of which a few projects will yield results of such significance as to justify their prosecution into the realm of really advanced investigation. The Society is worthy of such a goal and should move toward it. Power and support will follow accomplishment as they have in the past and as they are now doing. Chairmen of the Committee on Research will continue to serve at the high level of past and present incumbents.

Business and Financial Policy Studies

The second of three special committees mentioned above is one on *Business and Financial Policies* under the chairmanship of E. N. McDonnell. The distinction between the work of this committee and that of the Finance Committee is that the Finance Committee is concerned primarily with the operating budget, its determination and supervision. The Committee on Business and Financial Policies is concerned with potential changes and improvements in the financial and business structure of the Society. Its achievements during the past year have been substantial. Under its leadership increased amounts have come to the Society from the operation of expositions, also increased help in the editing of papers through the publisher of the JOURNAL.

The Committee has under consideration several possibilities for improving the financial status of the Society. In this connection it should be noted that the Society has up to the present time not increased its dues from the low amount of $18 per year to which they were reduced in the depression of the "thirties." Some members may not recall that the dues were put at $25 per year about a quarter of a century ago in order to provide an allocation of $10 per member per year toward research. They were reduced later to $18 per year. Support for research has been steadily increasing and in spite of the

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low dues rate, about 50 percent of research income came from dues this year. Funds for the expanding general operations of the Society may not come so easily. This presents a difficult financial problem which has not been solved. It is quite likely that increased support for general activities of the Society must be found. The need has been met up to the present time by the rapid increase in members. Should such increase not continue, and even if it should, it is likely that either an increase in dues or the allocation of certain funds now going to research from general society operations will be required. This problem confronts the incoming administration. It would not be surprising if recommendations in the direction of increased dues prove necessary. It will be not the desire of the new administration to make such a recommendation, but circumstances may lead there.

The third special committee is the one under the chairmanship of Dean Seeley to which former reference was made. It deals with the examination of the administrative policies of the Society as distinguished from the business relationships. These obviously include the relations between the functions belonging in the general office of the Society in New York and those pertaining to the Laboratory. Prominent among these is the problem of publication, to which reference was made. Many of these relationships are the concern of other committees and are defined in the Constitution and By-Laws. They should be re-examined as conditions change. The chairman of the committee has been prevented from giving this subject the attention he desired by reason of unexpected and extremely heavy professional duties. Accomplishments in one or two areas, however, have been real.

Mention could be made, of course, of many other active groups. The Chapter Relations Committee under chairman R. F. Taylor has been extremely active and has circulated bulletins to all chapters at frequent intervals throughout the year.

Vice-President Tuve, as chairman of the Committee on Meetings, has carried a heavy burden. One of the most interesting items of his report to the Council on November 10 was the recommendation that the following subjects be given prominence in technical programs of future meetings of the Society.

1. Transportation Air Conditioning.
2. Fuels and Combustion.
3. Evaporative Cooling and Condensing.
4. Solar Heat Transmission.
5. Physiological Effects.
6. Panel Heating.
7. Industrial Ventilation.
8. Weather Design.
9. Air Cleaning.

Semi-Annual Meeting

For the large proportion of the membership who were unable to attend the summer meeting at Coronado, the President reports its success. The relatively small attendance permitted intimate association of the members present and full discussion of papers. Rarely has there been more vigorous and profitable participation in technical sessions than was the rule at Coronado. The hospitality of the Southern California Chapter and its organizing committees and the felicitous combination of comfort and beauty in the meeting place made everyone present an enthusiast.

Without intentional neglect of any of the important committees to whom specific reference has not been made, the President desires to call attention to the vital and continuing importance of the work of the Guide Publication Committee. Under the chairmanship of R. S. Dill of the Bureau of Standards, the Committee has carried on its work efficiently and aggressively during the past year. Members will be interested to know that the Guide Publication Committee is an overlapping committee made up of three groups, each serving for three years but starting in successive years. Therefore, two-thirds of the membership in a given year consists of those already acquainted with the committee and its work. The committee has assigned itself a similar three-year task which is the re-writing of THE GUIDE every three years. Each year about one-third of the Chapters are given major revision, another third moderate revision, and a third are allowed to stand substantially as they are. Now that THE GUIDE has attained its present size and complexity, this is in itself an ambitious program. The present year has seen progress both in the revision of chapters and in the initiation of revision of some chapters for which a period of more than one year is necessary, if thoughtful and authoritative results are to be had. Since THE GUIDE has become the standard national reference book in its field, since its acceptance is now indicated through publication of over 18,000 copies contemplated for the year 1948, the importance of systematic and thorough consideration of the validity and up-to-dateness of its chapters are indicated.

The President hopes that the chairmen of a number of committees whose activities have not been here reviewed will present them to the membership. In particular, he hopes that the chairman of the Committee on Membership will give a full report and likewise the chairman of the Nominating Committee, a committee which for the first time has operated under the new provisions of the Society.

Teamwork Appreciated

The wide participation in the work of the Society by its members, chapters, committees, Council, staff and officers emphasizes more than ever the importance of teamwork. The year just passed has seen evidence of unusually high performance to meet this requirement. Chairmen of committees have been careful to consult other committees whose duties might hinge upon problems which they had under consideration. Officers of the Society have been considerate of the interests and activities of one another. The executive staff has recognized the differentiation in tasks between the Laboratory and the general headquarters and frequent conferences have been held to remove possible administrative difficulties. The net result has been the devotion of energy primarily to accomplishment rather than to elimination of difficulties. The President expresses appreciation on behalf of the Society to those who have made its work the success that the past records. And he also pays tribute to the high sense of devotion and the unlimited expenditure of energy given to administrative duties by the Secretary, the Director of Research, the Technical Secretary and the Assistant to the President, to mention only the leaders. The Society has a great team in its administrative staff. If channels are kept clear so that new ideas and new abilities can be recognized equally, there need be no foreseeable limit to worthwhile accomplishment.

Finally, it is important to recognize that the President of the Society is not an executive in the sense of a corporation president nor even a university president. His task is primarily to keep up with what the Society is doing, to lend a hand, to coordinate and make more effective the work and programs, to encourage the members of the staff and committees to accept responsibility, show initiative and lead the Society forward as rapidly as technological progress and civilization lead the field of air conditioning. The Society is only as strong as the participation which it receives from its membership. Judged by this standard it has an outstanding present and great promise for the future.

Respectfully submitted,
Baldwin M. Woods
PRESIDENT

Treasurer's Report

John F. Collins, Jr., Pittsburgh, Pa., briefly outlined the method of handling the Society's finances, stating that the Secretary disburses funds in accordance with the budget adopted by the Council and periodically submits to the Treasurer statements of all expenses so that funds can be transferred to the Secretary's Account. Vouchers for the transfer of funds are approved by the chairman of the Finance Committee and all checks from the Treasurer's Account are signed by the President and Treasurer. The

books of the Society are audited annually by a certified public accountant appointed by the Council.

Mr. Collins quoted from the auditor's report and pointed out that our accounting covers three divisions, general Society activities, publications, and research. He gave some contrasting figures for the fiscal year ending October 31, 1946 and the current fiscal year, which indicated that general Society expense exceeded income by $3,594.00 and $16,875.00 respectively whereas THE GUIDE showed a surplus during each of these years because of the increase in number of copies printed.

On Research, Mr. Collins said that the 1946 expenses exceeded income by $11,779.63 and for 1947, total income amounted to $72,443.05 with expenditures of $82,032.59, a difference of $9,589.54. He pointed out that complete operations for 1946 showed a net income of $726.94, whereas for 1947 the net excess of expenses over income was $4,003.76. The detailed figures he said are summarized in the accountant's report.

He also pointed out that in the total expense some capital expenses were included, but it was clearly evident that during the past year income from membership dues was not sufficient to balance the services rendered to the Society's members.

Commenting on the Cleveland Laboratory, Mr. Collins pointed out that the appraised value was $137,000 and the purchase price two years ago was $70,000. He mentioned that contributions to the Mortgage Retirement Fund had permitted substantial payments, so that as of October 31, 1947 the balance due on the mortgage was $20,125.00. Payments since that time have reduced it to $14,000.00.

Accountant's Report

Frank G. Tusa & Co.
Certified Public Accountants
52 William Street
New York

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS,
51 Madison Avenue,
New York, N. Y.

Gentlemen:

Pursuant to your request, we examined the books of account and records of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—New York, N. Y. and the related funds for the fiscal year ended October 31, 1947 and submit herewith our report.

The audit covered a verification of the Assets and Liabilities as of the close of business October 31, 1947. Also, for the fiscal year then ended, the recorded cash receipts were traced into the depositories, the cancelled bank checks were inspected and compared with the record of cash disbursements, the disbursements were supported by payment vouchers and the dues income and the interest income from savings accounts and securities was accounted.

A Balance Sheet reflecting the financial condition of the Society as of the close of business October 31, 1947 is submitted herewith and your attention is directed to the following comments thereon:

CASH

The cash on deposit was verified by direct communication with commercial and savings banks and reconcilement of the balances reported to us with those reflected by the books of the Society. A schedule of cash is included as part of this report.

Checks representing the cash on hand for deposit were inspected by us and the petty cash counted.

MARKETABLE SECURITIES

The securities shown on the subjoined schedule were verified by direct communication with the Bankers Trust Company, where same are deposited for safe-keeping. This asset has been included in the balance sheet at the cost of acquisition plus the accumulated and accrued interest earned thereon.

ACCOUNTS RECEIVABLE

A trial balance of the membership dues receivable taken as of the close of business October 31, 1947 was classified as to membership and aged as follows:

CLASSIFICATION	Total	1947	1946	Prior
Members	$ 4,458.50	$3,220.50	$ 643.50	$ 594.50
Associates	6,107.50	4,623.00	1,147.50	337.00
Juniors	413.00	287.50	85.50	40.00
TOTALS	$10,979.00	$8,131.00	$1,876.50	$ 971.50

CLASSIFICATION	Total	October	September	Prior
Guides (Advertising and Copy Sales)	$ 6,982.16	$3,397.45	$1,357.84	$2,226.87
Transactions	336.09	12.50	61.45	262.14
Books and Reprints	460.64	87.63	80.86	292.15
Art and Engraving	54.22	—0—	—0—	54.22
Sundry	640.75	243.24	.75	396.76
TOTALS	$ 8,473.86	$3,740.82	$1,500.90	$3,232.14

The reserves for dues and sundry accounts receivable doubtful of collection as provided in our opinion are ample.

INVENTORIES

The emblems and transactions on hand on October 31, 1947 were counted by us and the guide paper was verified by direct communication with the printers. All inventories were priced and computed by us.

A schedule of transactions inventories follows:

Volume	Year	Quantity	Price	Amount
Prior	Prior	1,350	$1.00	$1,350.00
47	1941	96	1.32	126.72
48	1942	118	1.42	167.56
49	1943	257	1.39	357.23
50	1944	220	1.82	400.40
51	1945	395	1.91	754.45
TOTAL				$3,156.36

EXCHANGES

The open debits in this account represent accommodations for cuts and traveling expenses to council members.

MORTGAGES RECEIVABLE

The Society holds a mortgage dated November 15, 1945 on which Cyril and Ada R. Tasker are jointly liable to a balance of $6,706.56. This indenture covers premises 3538 Edison Road, County of Cuyahoga, Cleveland Heights, Ohio is payable in monthly installments of not less than $81.04 including interest and matures on or before November 15, 1955.

PERMANENT ASSETS

The real estate, furniture and library were included herein per the book figures. During the current fiscal year the sum of $2,143.57 was expended in additional improvements to the building housing the Research Laboratory at Cleveland, Ohio. Depreciation of these assets has been provided for at the following annual rates:

Building and Improvements	2 per cent
Furniture and Fixtures	10 per cent

DEFERRED CHARGES

We have deferred to future operations one-sixth of the subscriptions paid to Heating, Piping and Air Conditioning for the reason that subscriptions were paid on a calendar year basis while the fiscal year of the Society ends on October 31st. We also deferred to future operations promotion expenses of Guide copy sales incurred for the 1948 Guide. Prepaid costs on Volume 53 of the Transactions were also deferred.

ACCOUNTS PAYABLE

All purchase invoices found on file that were applicable to the operations of the current fiscal period were listed and the proper liability therefor reflected in the attached balance sheet.

TAXES WITHHELD

The sum of $562.60 represents Federal Income Taxes withheld from salaries paid to employees during the month of October, 1947.

DEFERRED INCOME

We have reflected as deferred income on the subjoined Balance Sheet the following dues prepaid to the Society as of October 31, 1947:

ELECTED MEMBERS		
Members	$520.98	
Associates	704.51	
Juniors	93.00	
Students	27.50	$1,345.99
PROPOSED MEMBERS		351.00
TOTAL		$1,696.99

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RESERVE FOR PUBLICATIONS

In accordance with provision made in the 1947 Budget we have reserved the sum of $6,000.00 to cover publication of Transactions Volume 53.

MORTGAGE PAYABLE

The mortgage payable on the real estate located at 7218 Euclid Avenue, Cleveland, Ohio, held by the Cleveland Trust Co. was verified by direct communication. This indenture is dated February 11, 1946 matures on February 11, 1956 and bears interest at the rate of four and one-half (4½%) per cent per annum payable quarterly together with installments of $875.00 each on March 15th, June 15th, September 15th and December 15th. The original mortgage of $35,000.00 has been reduced by installments and payments on account so that on October 31, 1947 there was a balance due of $20,125.00. There is held in reserve in the MORTGAGE PAYABLE REDUCTION FUND the sum of $8,720.98 for the further reduction of the said mortgage.

FUNDS

An Analysis reflecting the changes that occurred in the following Funds during the fiscal year ended October 31, 1947 has been made a part of this report:

General Fund
Reserve Fund
Endowment Fund
F. Paul Anderson Fund
Mortgage Payable Reduction Fund

INCOME AND EXPENSES

A Statement in summary form reflecting the Income and Expenses and comparable items budgeted for the fiscal year ended October 31, 1947 of the Society Guide and Research follows:

	ACTUAL	BUDGET
SOCIETY		
Income	$ 86,083.33	$ 84,300.00
Less: Expenses	102,959.05	100,485.00
NET OUT-GO	16,875.72	16,185.00
GUIDE		
Income	94,697.29	78,700.00
Less: Expenses	72,235.79	72,715.00
NET INCOME	22,461.50	5,985.00
SOCIETY INCLUDING GUIDE		
Income	180,780.62	163,000.00
Less: Expenses	175,154.84	173,200.00
NET INCOME—OUT-GO	$ 5,585.78	$ 10,200.00
RESEARCH		
Income	$ 72,443.05	$ 75,000.00
Less: Expenses	82,032.59	75,000.00
	$ 9,589.54	—0—
COMBINED SOCIETY AND RESEARCH		
Income	$248,223.67	$233,000.00
Less: Expenses	252,227.43	243,200.00
NET OUT-GO	$ 4,003.76	$ 10,200.00
CAPITAL ITEMS		
New Equipment for Research	$ 2,637.23	—0—
Initiation Fees to Reserve Fund	6,669.00	7,500.00
Improvements to Real Estate	2,143.57	—0—
TOTAL	$ 11,449.80	$ 7,500.00

Respectfully submitted,

FRANK G. TUSA & CO.,
Certified Public Accountants.

Dated January 12, 1948

BALANCE SHEET

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
New York, N. Y.
October 31, 1947

ASSETS

GENERAL FUND			
CASH			
On Deposit	$32,704.14		
On Hand	100.00	$32,804.14	
INVESTMENTS (AT COST)			
Securities (Market Value $37,426.41)	34,439.50		
ADD: Accumulated Interest	$ 2,406.40		
ADD: Accrued Interest	125.00	2,531.40	36,970.90
ACCOUNTS RECEIVABLE			
Membership Dues		10,979.00	
LESS: 40% for Research	4,226.40		
LESS: Reserve for Doubtful	2,046.89	6,273.29	
		4,705.71	
Advertisers and Sundry Debtors	8,473.86		
LESS: Reserve for Doubtful	112.50	8,361.36	13,067.07
INVENTORIES			
Transactions		3,156.36	
Emblems		167.64	
Guide Paper		7,396.78	10,720.78
EXCHANGES			409.75
MORTGAGE RECEIVABLE			6,706.56
PERMANENT			
Land and Building	70,120.80		
Improvements	14,800.16		
	84,920.96		
LESS: Reserve for Depreciation	2,461.65	82,459.31	
Library		300.00	
Furniture and Fixtures	3,606.32		
LESS: Reserve for Depreciation	1,832.40	1,773.92	84,533.23
DEFERRED CHARGES			
Prepaid HPAC Subscriptions		1,835.77	
1948 Guide Promotion		1,040.08	
Transactions—Volume 53		59.21	2,935.06 $188,147.49
RESERVE FUND			
Cash on Deposit			6,352.20
Securities at Cost (Market Value $43,647.80)		40,145.00	
ADD: Accumulated Interest		3,502.80	43,647.80 50,000.00
F. PAUL ANDERSON FUND			
Cash on Deposit		34.61	
Cash on Hand for Deposit		25.00	59.61
Securities at Cost (Market Value $956.00)		1,000.00	
ADD: Accrued Interest		12.50	1,012.50 1,072.11
MORTGAGE PAYABLE REDUCTION FUND			
Cash on Deposit			7,786.28
Cash on Hand for Deposit			934.70 8,720.98
			$247,940.58

LIABILITIES AND FUNDS

GENERAL FUND			
LIABILITIES			
ACCOUNTS PAYABLE			$11,685.14
DUE TO RESEARCH FUND			6,930.58
FEDERAL WITHHOLDING TAX			562.60
ACCRUED ACCOUNTS			
Additional Compensation—Employees			6,840.83
DEFERRED INCOME			
Prepaid Membership Dues	$1,345.99		
LESS: 40% Prepaid to Research	490.20	855.79	
Dues Prepaid by Candidates for Membership		351.00	
Initiation Fees Prepaid by Candidates for Membership		1,100.00	2,306.79
RESERVE FOR PUBLICATION			
Transactions (1947) Volume 53			6,000.00
MORTGAGE PAYABLE			
Cleveland Trust Company			20,125.00
TOTAL LIABILITIES			54,450.94
GENERAL FUND			133,696.55 $188,147.49

NOTE "A"—This Balance Sheet is subject to the comments contained in the letter attached to and forming a part of this report

RESERVE FUND			
Principal			50,000.00
F. PAUL ANDERSON FUND			
Principal			1,033.78
Unexpended Income			38.13 1,072.11
MORTGAGE PAYABLE REDUCTION FUND			
Principal			8,720.98
			$247,940.58

BUDGET COMPARISON—SOCIETY ACTIVITIES

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—
New York, N. Y.

For the Fiscal Year Ended October 31, 1947

	Actual	Budgeted	Increases	Decreases
MEMBERSHIP INCOME				
DUES—RENEWALS				
100—Members	$ 26,966.40	$ 26,000.00	$ 966.40	$
101—Associates	21,662.10	21,600.00	62.10	
102—Juniors	1,860.00	2,500.00		640.00
103—Students	15.00	75.00		60.00
	50,503.50	50,175.00	1,028.50	700.00
DUES—NEW MEMBERS				
104—Members	1,836.00	3,240.00		1,404.00
105—Associates	4,557.00	2,600.00	1,957.00	
106—Juniors	969.50	1,000.00		30.50
107—Students	411.00	75.00	336.00	
	7,773.50	6,915.00	2,293.00	1,434.50
TOTAL DUES INCOME	$ 58,277.00	$ 57,090.00	$ 3,321.50	$ 2,134.50
OTHER INCOME				
108—Initiation Fees	6,669.00	7,500.00		831.00
109-110—Emblems and Certificate Frames	399.41	700.00		300.59
	7,068.41	8,200.00	—0—	1,131.59
TOTAL INCOME FROM MEMBERS	$ 65,345.41	$ 65,290.00	$ 3,321.50	$ 3,266.09
INCOME FROM PUBLICATIONS				
115—Editorial Contract	17,500.00	17,250.00	250.00	
116—Guide Sales and Advertisements	22,461.50	5,985.00	16,476.50	
117—Sale of Transactions	1,177.47	600.00	1,177.47	
118—Income from Books, Reprints, Etc.	482.45	500.00		17.55
119—Sales Codes	72.09	10.00	62.09	
120—Servicemen's Fees	92.00	50.00	42.00	
	42,385.51	24,395.00	18,008.06	17.55
INCOME FROM INVESTMENTS				
125—Interest—Savings A/C	123.69	50.00	73.69	
126—Interest—Securities	330.00	250.00	80.00	
127—Interest—Cert. of Indebt.	14.86	—0—	14.86	
Interest—Mortgage	310.36	300.00	10.36	
	778.91	600.00	178.91	
PROFIT FROM SALE OF FURNITURE	35.00		35.00	
TOTAL CURRENT INCOME	108,544.83	90,285.00	21,543.47	
COLLECTION OF PRIOR YEARS DUES	2,729.30	2,000.00	729.30	
TOTAL INCOME	$111,274.13	$92,285.00	$22,272.77	$3,283.64
OPERATING EXPENSES				
150—President's Fund	1,780.93	2,500.00		719.07
151—Council Travel to Meetings	3,600.29	3,500.00	100.29	
160—Executive Committee	—0—	100.00		100.00
161—Finance Committee	38.91	200.00		161.09
162—Membership Committee	71.91	2,000.00		1,928.09
170—Admissions and Adv. Comm.	582.77	500.00	82.77	
171—Constitution and By-Laws	275.61	100.00	175.61	
172—Nominating Committee	1,955.05	2,000.00		44.95
173B—Chapter Delegates Committee	2,829.52	4,000.00		1,170.48
173C—Chapter Relations	88.12	250.00		161.88
173D—Kardex Books to Chapters	138.92	50.00	88.92	
201—A.S.A.—Membership	100.00	100.00	—0—	
204—Membership Certificates	920.55	500.00	420.55	
206—Medals and Awards	147.86	250.00		102.14
	12,530.44	16,050.00	868.14	4,387.70
MEETING EXPENSES				
163—Meetings	3,363.14	2,500.00	863.14	
173A—Speakers to Chapters	1,558.96	1,500.00	58.96	
327—Chapter Meeting Allowance	900.00	900.00	—0—	
	5,822.10	4,900.00	922.10	
PUBLICATION EXPENSES				
200—Members Subscriptions H.P.A.C.	11,012.15	10,000.00	1,012.15	
202—Transactions	13,831.95	5,500.00	8,331.98	
203—Membership Roll	2,267.47	1,500.00	767.47	114.50
164—Standards (Including Codes)	35.50	150.00		
	27,147.10	17,150.00	10,111.60	114.50
HEADQUARTERS EXPENSES				
210—Salaries—Secretary and Staff	32,751.01	39,000.00		6,248.99
211—Additional Compensation	6,920.92	4,000.00	2,920.92	
212—Traveling—Secretary and Staff	1,987.21	1,500.00	487.21	
213—Rent and Light	4,101.39	4,000.00	101.39	
214—Telephone	1,227.44	900.00	327.44	
215—Telegraph	540.38	400.00	140.38	
216—Postage	3,750.91	2,500.00	1,250.91	
217—General Printing	909.07	800.00	109.07	
218—Office Supplies	1,926.00	750.00	1,176.00	
219—Addressing and Address Changes	235.71	250.00		14.29
220—Professional Services	1,535.50	3,100.00		1,564.50
221—Bank Charges	55.53	100.00		44.47
222—Depreciation—Furniture and Fixtures	327.44	250.00	77.44	
223—General Office Expense	1,753.78	1,000.00	753.78	
224—Pension—October 1, 1947	80.09	2,000.00		1,919.91
TOTAL HEADQUARTERS EXPENSES	58,102.38	60,550.00	7,344.54	9,792.16
LESS: 30% Charge to Guide	17,430.71	18,165.00	—0—	734.29
	40,671.67	42,385.00	7,344.54	9,057.87
PROVISION FOR UNCOLLECTIBLE DUES	2,297.37		2,297.37	
RESEARCH FUND RAISING CAMPAIGN	9,490.37	15,000.00		5,509.63
ALLOCATION TO RESEARCH FUND	5,000.00	5,000.00		
INITIATION FEES TO RESERVE FUND	6,669.00		6,669.00	
	23,456.74	20,000.00	8,966.37	5,509.63
TOTAL EXPENDITURES	$109,628.05	$100,485.00	$28,212.75	$19,069.70

BUDGET COMPARISON—GUIDE

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
New York, N. Y.

For the Fiscal Year Ended October 31, 1947

	Actual	Budgeted	Increases	Decreases
INCOME				
116—Guide Advertisements	$43,477.98	$41,200.00	$ 2,277.98	$
Guide Copy Sales	51,219.31	37,500.00	13,719.31	
	$94,697.29	$78,700.00	$15,997.29	
COST OF GUIDE				
Paper	$ 7,870.30	$ 5,000.00	$ 2,870.30	$
Composition and Presswork	16,841.34	18,000.00		1,158.66
Binding	11,038.25	10,500.00	538.25	
Cartons	3,803.99	650.00	3,153.99	
Engraving and Artwork	1,006.46	800.00	206.46	
Editorial Salaries	2,583.28	3,000.00		416.72
Editorial Survey	130.29	—0—	130.29	
	43,273.91	37,950.00	6,899.29	1,575.38
ADVERTISING SALES PRODUCTION				
Salaries and Commissions	3,108.13	5,000.00		1,891.87
Booklets, Printing, Postage	436.03	1,000.00		563.97
Traveling, Etc.	223.56	750.00		526.44
	3,767.72	6,750.00		2,982.28
COPY SALES PROMOTION AND DISTRIBUTION				
Printing, Multigraphing, Etc.	1,264.15	2,500.00		1,235.85
Mailing, Express and Postage	5,713.63	6,500.00		786.37
Indexing	—0—	100.00		100.00
	6,977.78	9,100.00		2,122.22
GUIDE COMMITTEE EXPENSE	785.67	750.00	35.67	
TOTAL	54,805.08	54,550.00	6,934.96	6,679.88
APPORTIONABLE EXPENSES	17,430.71	18,165.00		734.29
GUIDE GROSS EXPENSE	72,235.79	72,715.00	6,934.96	7,414.17
NET INCOME	$22,461.50	$ 5,985.00	$ 9,062.33	$ 7,414.17

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Frank G. Tusa & Co.
Certified Public Accountants
52 William Street
New York

Research Laboratory of the
American Society of Heating
and Ventilating Engineers
51 Madison Avenue,
New York, N. Y.

Gentlemen:

Pursuant to your request, we examined the books of account and records of the Research Laboratory of the American Society of Heating and Ventilating Engineers—Cleveland, Ohio and New York, N. Y. for the fiscal year ended October 31, 1947 and submit herewith our report.

The audit covered a verification of the Assets and Liabilities as of the close of business October 31, 1947. Also, for the fiscal year then ended, we traced the recorded cash receipts into the depositories; we inspected the cancelled bank checks which we compared with the record of cash disbursements; we supported the disbursements by payment vouchers; we accounted for the dues income and interest income from savings accounts.

A Balance Sheet reflecting the financial condition of the Research Funds as of the close of business October 31, 1947 is submitted herewith and your attention is directed to the following comments thereon:

CASH

The Cash on Deposit was verified by direct communication with Commercial and Savings Banks and reconcilement of the balances reported to us with those reflected by the books of the Laboratory:

Checks representing the Cash on Hand for Deposit were inspected by us.

Petty Cash and the Traveling Imprest Fund are included per verification from the Cleveland Office.

PERMANENT

The Director of Research furnished us with schedules of Instruments, Equipment, Furniture and Fixtures of which summaries follow:

Equipment	Value	Depreciation	Balance
Purchased	$21,646.90	$ 7,057.84	$14,589.06
Constructed	800.00	160.00	640.00
Donated	4,120.06	1,001.66	3,118.40
TOTALS	$26,566.96	$ 8,219.50	$18,347.46
Instruments	$11,734.85	$ 4,193.86	$ 7,540.99
Laboratory Equipment	7,295.79	2,225.46	5,068.33
Furniture and Fixtures	7,538.32	1,800.18	5,738.14
TOTALS	$26,566.96	$ 8,219.50	$18,347.46

The purchased equipment has been valued at cost, the constructed equipment has been appraised as at the date of completion and the donated equipment has been stated at market value. In addition the laboratory possesses fully depreciated equipment having a residual value of $522.50 which has not been reflected in the Balance Sheet.

ACCOUNTS PAYABLE

All purchase invoices found on file that were applicable to the operations of the current fiscal period were listed and the proper liability therefor reflected in the attached Balance Sheet.

DEFERRED INCOME

We have allocated to future operations the income applicable to the uncompleted portion of the projects or to be commenced.

Exposition contributions in the sum of $8,598.69 representing the excess over $7,500.00 have been deferred to future operations in accordance with Council's resolution contained in the minutes of April 14, 1947.

FUNDS

Mr. C. F. Roth of the International Exposition Co. turned over to the Laboratories the additional sum of $4,000.00 which resulted from economies in the operation of the Cleveland show.

In accordance with the Council Minutes of April 15, 1947 we recommended that this sum could be applied "toward any improvement that would produce recurring benefits and would be useful over a long period, or that it be used as a reserve fund against the time when the Research Income becomes reduced and may need stabilization in periods of depression, or in the alternate years when the Exposition is not held."

Based on the foregoing we set-up the sum as a Reserve Fund on the subjoined Balance Sheet.

An Analysis of the Research Fund reflecting the changes that occurred therein during the fiscal year ended October 31, 1947 also is included herein.

INSURANCE

The following fire insurance coverages are being carried by the Research Laboratories which contain unexpired premiums in the sum of $747.08:

Building	$116,000.00
Contents	15,000.00

Respectfully submitted.
FRANK G. TUSA & CO.,
Certified Public Accountants

January 12, 1948

BALANCE SHEET

American Society of Heating and Ventilating Engineers
Research Fund
New York, N. Y.
October 31, 1947

ASSETS

RESEARCH FUND			
CASH			
ON DEPOSIT			
Treasurer's Account—Bankers Trust Co.	$ 786.33		
Secretary's Account Chase National Bank	8,737.89		
Director's Account—Cleveland Trust Co.	1,090.25		
Thrift Account—Bank for Savings	5,447.04	$16,061.51	
ON HAND FOR DEPOSIT			
Director's Account		413.99	
ON HAND			
Cleveland, Ohio		50.00	
TRAVEL IMPREST FUND		200.00	$16,725.50
DUE FROM SOCIETY			6,930.58
PERMANENT			
Laboratory Equipment, Furniture and Fixtures	26,566.96		
LESS: Reserve for Depreciation	8,219.50	18,347.46	
Tools and Supplies		300.00	18,647.46
DEFERRED CHARGES			
Unexpired Insurance Premiums			747.08
TOTAL RESEARCH FUND			43,050.62
RESEARCH ENDOWMENT FUND			
CASH ON DEPOSIT			
Bank for Savings			633.67
			$43,684.29

LIABILITIES AND FUND

RESEARCH FUND			
ACCOUNTS PAYABLE		$ 250.00	
ACCRUED ACCOUNTS			
Real Estate Taxes	$ 1,750.00		
Interest on Mortgage	113.20		
Salaries	91.41	1,954.61	
FEDERAL WITHHOLDING TAXES		587.92	
DEFERRED INCOME			
PROJECTS			
Technical Advisory Committee on Glass	$7,291.37		
Summer Cooling	1,859.45		
Sound Energy Studies	574.39		
Weather Design Data	104.90		
Heat Losses Due to Infiltration	188.75	10,018.86	
EXPOSITION		8,598.69	18,617.55
DUES—MEMBERS AND ASSOCIATES			
40 Per Cent of 1947 Dues Prepaid in 1947		490.00	$21,900.28
RESERVE FUND		4,000.00	
RESEARCH FUND		17,150.34	21,150.34
TOTAL RESEARCH LIABILITIES AND FUNDS			43,050.62
RESEARCH ENDOWMENT FUND			
Principal			633.67
			$43,684.29

BUDGET COMPARISON

American Society of Heating and Ventilating Engineers
Research Fund
New York, N. Y.

For the Fiscal Year Ended October 31, 1947

	Actual	Budget Provision	Increases	Decreases
INCOME				
MEMBERS DUES	$33,695.61	$36,000.00	$	$2,304.39
CONTRIBUTIONS				
Council	5,000.00	5,000.00		
Exposition	7,500.00	7,500.00		
General	7,183.00	10,500.00		3,317.00
Earmarked	19,047.49	16,000.00	3,047.49	
INTEREST	16.95	–0–	16.95	
TOTALS	$72,443.05	$75,000.00	$3,064.44	$5,621.39
EXPENSES				
Committee Expenses	$ 2,047.48	$ 1,000.00	$1,047.48	
Staff Salaries	48,376.02	45,950.00	2,426.02	
Laboratory Expenses	15,156.06	11,950.00	3,206.06	
Laboratory Maintenance	9,108.95	8,500.00	608.95	
Cooperative Contracts	7,344.08	7,600.00		255.92
TOTALS	$82,032.59	$75,000.00	$7,288.51	$ 255.92

Report of Council

The Council for 1947 was organized at Cleveland, Ohio, January 30, at the Hotel Statler with only one member absent.

Selection of meeting places for 1948 meetings were made and also the 1949 Annual Meeting place was approved.

President Woods announced the appointment of Council and Special Committees, and appointment of the Secretary, Technical Secretary and Assistant to the President were confirmed.

Other routine business included the selection of depositories for Society funds, approval of the lease for the headquarters office in New York, reappointment of the Society's Certified Public Accountant and authorization to make a substantial payment from the mortgage reduction fund.

President Woods announced the appointment of two committees, one on Business and Financial Operations, and the other on Society Administrative Problems with E. N. McDonnell and Dean L. E. Seeley, respectively as chairmen.

In April the Council held its spring meeting at the Hotel Stevens, Chicago, and all Officers were present and 10 of the 14 Council Members were in attendance.

The report on the 1948 Exposition indicated that a large part of the available space at Grand Central Palace, New York, was under reservation.

The Council received reports on the progress of research work, the fund raising activities, and recommendations from the Meetings Committee on future meeting places until 1950.

The Finance Committee recommended new advertising rates for the HEATING VENTILATING AIR CONDITIONING GUIDE effective in 1948, based on greatly increased distribution of the Society's official handbook. The Finance Committee also reported further reduction in the mortgage by payment of an installment June 15.

A report on the development of the Pension Plan for staff members and the progress being made in assembling historical data by the History Committee were presented.

The June meeting of the Council was held at Coronado, Calif., with 12 of the 18 Officers and Council Members in attendance.

The Membership Committee reported a total membership of the Society in excess of 5,500. The Meetings Committee suggested a list of possible subjects for papers to be discussed at the 54th Annual Meeting.

The Committee on Promotion of Research brought a number of questions and suggestions before the Council with regard to research procedure as it involved fund raising plans.

R. F. Taylor, chairman of the Chapter Relations Committee, gave a detailed report and outline of seven items which were under consideration, the object of which was to assist Chapters.

The Council nominated five members to serve on the Committee on Research for a three-year term.

The Fall Meeting of Council was held in Pittsburgh on November 10, and 15 of the 18 Council Members were in attendance.

Upon a favorable report from the Executive Committee, the Exchange Service Plan with the *ASRE* was recommended for the coming year. A special design for a Chapter past president's emblem was authorized.

The Finance Committee presented a budget for 1948 covering the fiscal year ending October 31, 1948.

After adjustment of some items, approval was given to the budget and estimated income of $294,900 and expenditure of $294,050. This included budget for research of $96,100.

The report of the Special Committee setting membership grades was received and its recommendations referred to the special committee on Administrative Organization and the Constitution and By-Laws.

E. N. McDonnell reported on the work of the Business and Financial Operation which had developed a 10-year agreement for handling the Expositions and the signing of a contract was authorized.

The Committee on Constitution and By-Laws reported on the amendments to the By-Laws and indicated that it had consulted legal counsel so that the amendments would be in harmony with the New York State Membership Corporation Law and the new Charter of the Society. The Committee planned to submit a streamlined version of the Constitution and By-Laws for later consideration.

As required by the Constitution, the Council selected four members of the Nominating Committee and an Alternate as follows: R. H. Carpenter, New York; John James, Cleveland; J. E. Haines, Minneapolis; Art Theobald, Los Angeles; and H. King McCain, Atlanta, Alternate.

J. F. Collins, Jr., Chairman of the Pension Committee reported that the pension plan previously authorized by Council had been made effective as of October 1, 1947 for participation by two members of the headquarters staff and four of the Laboratory staff.

The F. Paul Anderson award was voted to James H. Walker, Detroit, for his outstanding contributions to the advancement of heating, ventilating and air conditioning as an engineer, executive and author and for his many distinguished services to the ASHVE which were rendered without thought of reward but only to give aid to his fellow members of the profession. The medal was presented to Mr. Walker before his untimely death on December 2, 1947.

The Meetings Committee reported on the details of the Annual Meeting Program.

During the meeting required action was taken on resignations, cancellation for nonpayment of dues and the voting of life membership to 15 members. All mandatory duties imposed by the Constitution and By-Laws of the Society were carried out.

Respectfully submitted,

THE COUNCIL

Report of the Secretary

The work of the Secretary's office in 1947 has been greatly increased because of a continuously growing membership, an expanded production and distribution of Society publications, many additional administrative problems resulting from the faster tempo of research and other major committee activities, with the attendant, larger correspondence and more detailed record keeping.

The Secretary's office has carried out all of the duties assigned of keeping all membership and financial records, handling elections of new members, handling all changes of addresses, editing the monthly JOURNAL, preparing the TRANSACTIONS and publishing THE GUIDE. A new function was the production of the research bulletins, just out, which required several hundred hours of staff time to prepare them for printing.

The planning of meeting programs involves much detailed effort with the committees in charge of arrangements.

The Secretary's office handles the arrangements for the trips of officers and all other speakers visiting Chapters, and during this year the following were included: Officers visited 13 Chapters and speakers visited 40 Chapters.

It is significant that between 800 and 900 members are serving on the many committees responsible for Society's extensive operations of which about 200 devote their work to research.

The Society with 6000 members has become a good sized operation involving an annual income of $180,987.88 and an expenditure of $168,203.90.

To give just a glimpse of some of the work that goes through the Secretary's office during the year, it might be enlightening to the members to ask—Did you Know?

That the Society received 979 applications for membership?

That the President and Secretary signed 1000 membership certificates?

That the Society issued 1800 checks which required the Secretary's signature?

That the Secretary received 18,000 checks?

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That labels for 16,800 users of THE GUIDE were addressed?

That 6000 changes of addresses were received?

That 60,000 sheets of stationery and over 100,000 envelopes were used?

To carry on the work the staff numbers 14 at the moment and is a little short handed to meet our requirements effectively.

As a result of a special survey recently completed, it is anticipated that some administrative improvements can be introduced during the coming year in order to give more adequate service to the members.

It is appropriate to express sincere appreciation to the officers and committees who devoted so much of their time to Society work and to pay special tribute to my associates on the staff who did so much to carry on the Society's work under the many trying conditions which were encountered in 1947.

Respectfully submitted,
A. V. HUTCHINSON,
SECRETARY

Nominating Committee

President Woods called upon Neil H. Peterson, San Francisco, Calif., chairman of the Nominating Committee, who said that many who have served on the Nominating Committee are aware of the difficulties experienced in the past few years. In 1946 the Nominating Committee numbered 36 and in 1947, in accordance with the new By-Laws the membership was 11, with two alternates. Many past members have mentioned the time consumed at meetings of the committee which require a total of from 10 to 20 hours. During the past year the committee held three sessions and required about six and one-half hours for the meetings. At the first meeting about 25 names were submitted for consideration. Between the first and second meetings about 25 more names were submitted. Biographies of all were prepared and circulated prior to the second meeting held at Coronado. The minutes of all meetings are being made available to the incoming Committee.

Mr. Peterson indicated that there had been some question in the minds of some of the officers and members regarding the new Committee set-up and how it would function, particularly with respect to the relationship between the seven members and one alternate selected by the chapter delegates and the four members and one alternate appointed by the Council.

Mr. Peterson said, "I think I speak for the Committee when I say that we had no serious difficulties. Our discussions were straight-forward, the meetings were conducted with dispatch, and I believe it is safe to say that there is no question that the new structure and reduced size of the committee is going to operate much more effectively."

New Constitution Adopted

As a preliminary to the report of the Committee on Constitution and By-Laws, President Woods mentioned that during the year the committee had asked for assistance from the Council as to the bearing that the laws of the State of New York might have on the revision of the Constitution and By-Laws which were under way, and it was found that it was necessary to have certain time intervals observed regarding notification of meetings and a new procedure for voting, which must be done either in person or by proxy. He explained that the use of proxies did not in any way change the secrecy of the ballot, and he pointed out that it was entirely proper for anyone attending the Annual Meeting to cast his vote and a ballot box had been placed at the registration desk for this purpose. He also stated that if a member was present and wished to change his vote, having previously voted by proxy, he could request the withdrawal of his former vote. He expressed the hope, however, that nearly everyone was so certain of his wishes that he would not want to change now.

President Woods explained that the announcement accompanying the ballots was inadequate, so that a supplementary postcard on the balloting procedure was mailed to all members. He reported some criticism of the fact that printed copies of the old and new By-Laws had not been supplied. He indicated that the preparation of the document was a fairly difficult undertaking because of the initial changes and also because the order and references were changed. He also gave some indication of the magnitude of the work of the tellers in handling 1800 ballots.

Before presenting his report, S. H. Downs, Kalamazoo, Mich., said that he wanted to express appreciation of the present committee for the work of the former chairman, the late William T. Jones, Boston, Mass., whose death occurred last summer. The present committee held several meetings and had endeavored to carry out its duties in accordance with the Constitution and By-Laws.

Mr. Downs referred to the fact that the membership had received notice by mail dated December 29, 1947, referring to the changes in the Constitution and By-Laws and the balloting on the amended Constitution. A report of the mail ballot on the Constitution is to be reported at the Tuesday morning session. At the present time the matter under consideration is the revised By-Laws. After pointing out the changes in the old By-Laws, he asked whether the amended By-Laws should be considered as a whole or whether they should be considered article by article.

On motion of W. A. Danielson, Memphis, Tenn., and seconded by A. W. Edwards, Cincinnati, Ohio, it was the sense of the meeting,

THAT the amended By-Laws should be considered as a whole.

President Woods called for a vote and declared the motion adopted without dissent.

President Woods then called for a discussion on the By-Laws and H. K. Ormsby, Jr., Syracuse, N. Y. inquired about **Article B-VIII**, *Section 11*, asking whether the one member required from each Chapter means one member being elected from each region by the Chapter Delegates Committee, or does it include the one who may be selected by the Council.

Mr. Downs stated that it referred to the Committee as a whole and does not specify which group that particular one has to come from.

L. C. Gross, Minneapolis, Minn., requested an explanation of **Article B-X**, *Section 3*, with regard to a Chapter's income other than from

its dues unless approval is obtained from the Council.

President Woods stated that the question had been raised by several chapter representatives and this matter was on the agenda for Council discussion on Tuesday evening.

It was President Woods' opinion that we can keep within the intent and not put on such rigorous constraints as to embarrass Chapters from carrying on any reasonable activities.

L. T. Avery, Cleveland, Ohio, inquired whether a vote for adoption was final or would a mail ballot be required.

President Woods said that the vote on the By-Laws at the meeting would be final.

President Woods asked whether there was any further discussion and then called for a vote on the motion of Mr. Avery, seconded by E. W. Gifford, Milwaukee, Wis.

To accept the amended By-Laws as submitted by the Committee on Constitution and By-Laws.

The motion was carried for the adoption of the amended By-Laws.

Mr. Downs said that after several consultations with the Society's attorney during the Fall it has been pointed out that in addition to our charter we have a Constitution, By-Laws, Rules and Regulations on Research, with several appendices, which we think might be removed. The committee had discussed with the attorney the matter of streamlining the entire document with the idea of removing duplication. He pointed out that under laws of the State of New York we are basically operating under the charter and that the court would consider the Constitution, By-Laws, Rules, Regulations, etc. merely as By-Laws. It was the hope of the committee that a sample of the streamlined version be submitted at this time to show just what might be done, but time did not permit the committee to offer such a document. It will, undoubtedly, be a problem for the incoming committee, unless the members here raise objection to the idea.

President Woods said that on behalf of the Society he wished to express the appreciation of the members for the work of the Constitution and By-Laws Committee which had done an excellent job under rather trying conditions.

Research

President Woods called upon L. P. Saunders, chairman of Committee on Research, for a report of the Committee (complete report published in March 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Water Curtain and Exhaust Ventilation Control Fires

President Woods then announced the presentation of the first technical paper, **A Method of Fire Control** by A. C. Bartlett (complete paper published in the November 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Mr. Bartlett gave an abstract of his paper pointing out the highlights and indicating the results which were obtained. He described a system that had been operated for fire prevention engineers, representatives of insurance companies, fire chiefs, and many other persons. He explained that it was merely a method of fire control to prevent the spread of smoke in multi-story buildings and he felt that the matter naturally fell within the province of the heating and ventilating engineers and presents a real challenge to the profession.

A. C. BUENSOD, New York, N. Y., said that the author had made an important contribution and pointed out that in the case of panic in a multi-story building that the entrance doors on the first floor would be opened to let people go out and he felt that an opening at the top of the building permitting the entrance of outdoor air might be a handicap.

H. M. NOBIS, Cleveland, Ohio, asked whether it would be possible to install in the first floor enough exhaust fan capacity to take care of the leaks and on the other floors similar fans which would start to operate as soon as the sprinkler system functions.

MR. BARTLETT, in referring to questions, stated that the system was designed to create a down draft on the second, third and fourth floors, etc., from an opening at the top of the building, and he pointed out that a fan will take its supply of air from the point of least pressure. He stated that if a system is designed so as to create more resistance to the flow of air through the openings on the first floor than through the openings on the upper floors, it is only a question of figuring how large a fan is required. There are, of course, certain limits to the amount of fan capacity which can be properly applied, but the matter is not a matter of economics, but of safety. The aim is to save human lives and the natural course of the fire should not be reversed by putting fans on the first floor, which might perhaps pull smoke and fire from the third floor. The object is to create a condition of static-effect and confine the fire to the floor on which it occurs so that the fire fighters can get at it with equal effectiveness from above or below.

President Woods announced that the second paper entitled **State Laws Concerning Industrial Exhaust Ventilation** by K. J. Caplan and A. D. Brandt would be presented by title and inquired if there was any discussion. (Complete paper published in the February 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Second Session—Tuesday, February 3, 9:30 a.m.

The second session convened at 9:30 a.m. in the Grand Ballroom of the Commodore Hotel, New York, with President Baldwin M. Woods presiding. President Woods called for the report of the Board of Tellers of the election, which was presented by C. S. Koehler, chairman of the Board of Tellers (Complete report published in the March 1948 JOURNAL SECTION).

The chairman announced that in accordance with the results of the election the officers were declared elected.

The chairman also announced that in accordance with the election he declared that the amended Constitution, as submitted to the members on December 29, 1947, was adopted.

M. W. Bishop, Chicago, Ill., chairman of the Membership Committee, presented a report stating that the membership as of January 1, 1948, was 5925, representing a net increase of 640 during the year, the total elections being 868, and resignations 228.

Referring to the resignations, Mr. Bishop stated that a large percentage of these was due to change of employment, by the resigning mem-

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bers, to fields not related to heating, ventilating and air conditioning.

An advancement of 46 members from Associate to Member grade was noted. Junior membership had increased by 95, and Student membership from 76 to 103.

An Associate Group Committee, consisting of seven members from zones approximately the same as used by the Nominating Committee, had been formed during the year and had been of great service to the Membership Committee. Mr. Bishop expressed appreciation of the splendid cooperation of Secretary Hutchinson and the New York staff, as well as R. F. Taylor, Houston, Tex., chairman of the Chapter Relations Committee.

On motion of R. L. Gifford, seconded by F. C. McIntosh, it was voted that the Report of Membership Committee be received and filed.

Chairman Woods spoke of the increased amount of work required in counting the ballots for 1948 due to change in the method of election, and stated that the appreciation of the Society was due the Board of Tellers for performing this arduous task.

Downward Projection of Heated Air

Chairman Woods then asked A. E. Stacey, Jr., vice-president elect, to assume the chair and conduct the technical session.

The first paper presented was **Downward Projection of Heated Air** by Linn Helander and C. V. Jakowatz, Manhattan, Kans. (published in the March 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

ELLIOT GODES, New York, N. Y., inquired whether the assumption mentioned in the paper that downward velocity and temperature of the stream at any horizontal section were uniform, had been corroborated by the tests. He also asked whether additional tests using divergent nozzles for downward projection of heated air were contemplated.

M. G. KERSHAW, Philadelphia, Pa., asked the authors whether test data had been obtained for distances greater than six feet below the discharge since in the application of down-blow heaters distances of 10, 15 and perhaps 25 ft were frequently encountered. He also asked what effect a series of nozzles would have on the pattern of the air stream.

C. S. LEOPOLD, Philadelphia, Pa., asked whether experiments had been conducted on downward projected air colder than the room air.

C. M. ASHLEY, Syracuse, N. Y., stated that Professor Helander had made an excellent first approach to a very difficult problem and recommended that the paper be given careful scrutiny and study.

LINN HELANDER, in reply to Mr. Godes, stated that the original assumptions had not been borne out by the test results since neither the velocity nor the temperature was found to be uniform across a horizontal section. Interference by walls, ceiling and floor affect the shape of the stream. The final formula was developed with three constants or factors which could be determined experimentally. One of these factors would take into account the variation in velocity from the center to the periphery of the air stream at any horizontal section. The author felt that the formula given did agree fairly well with the results if it were recognized that the bottom of the air stream would fluctuate within a range of 2 to 4 ft. It was possible that tests of divergent nozzles might be included as the program was continued.

Answering Mr. Kershaw, Professor Helander mentioned that the test orifice was located 20 ft above floor level, and that tests had been conducted in which the stream was projected downward a distance of 18 ft. As no tests had been conducted up to the present using a series of nozzles, no data had been obtained under these conditions.

In reply to Mr. Leopold's question, the author stated that while tests with air below room temperature were contemplated, none had been run up to the present time.

Discharge From a Long Slot Studied

The next paper, **The Discharge of Air from a Long Slot**, by Alfred Koestel and G. L. Tuve, Cleveland, Ohio, (published in the January 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*) was presented in abstract by Mr. Koestel who stated that the paper was the result of a cooperative research project carried on at Case Institute of Technology.

C. M. ASHLEY, Syracuse, N. Y. (WRITTEN): The authors are to be highly complimented for the excellent presentation of the results of this experimental program. While the material is of much interest from a theoretical point of view it unfortunately is not readily susceptible to practical use. The primary reason for this is that when the streams from different portions of a slot are permitted to converge, the stream tends to spread in a direction at right angles to the plane of the slot in a manner similar to the old fashioned gas jet. Since such slots are normally used in a horizontal direction the resultant discharge stream is in the form of a vertical sheet of air which is normally highly objectionable. For this reason, the use of vanes behind the slots is almost imperative except where the ratio of duct to outlet velocity is very low. In the interest of standardization and because of the loss of total pressure in the duct, such vanes are ordinarily made either straight or only slightly curved, thus tending to recover only a portion of the duct velocity pressure and thus giving more uniform discharge velocity.

In view of this situation, the data on duct losses is perhaps the most interesting material in the paper from a practical point of view and it would be helpful if this material could be expanded further.

Of theoretical interest is the relationship between curves B and C of Fig. 6 indicating a slight decrease of orifice coefficient based on outlet static pressure with an increase of kinetic energy.

G. B. PRIESTER, Baltimore, Md., called attention to the statement in the paper that "static pressure regain along the duct is encountered in any design that involves a dead-end duct of uniform cross section with side outlets uniformly spaced." He felt that the computation of static regain was extremely important in proper design of duct systems and referred to the method as explained in the book *Modern Air Conditioning, Heating and Ventilating* by Carrier, Cherne and Grant. He believed that the static regain method was sufficiently important so that it should be included in THE GUIDE.

Referring to the paper, Mr. Priester stated that if the data from Fig. 8 were included in Fig. 9, and the curve in Fig. 9 extended, then the curve would be straight instead of curved at the extreme right as shown.

Mr. Priester asked whether it was correct to conclude from the paper that a narrow slot would give the best performance, and that the throw or blow does not vary a great deal as the slot width is varied. Also, it appeared that for a given air quantity and a given duct length, that the ratio of the slot to duct area should be less than 0.4 for good air distribution, and that the length of the throw of the air stream was practically fixed regardless of slot width. The width of slot apparently had a definite effect upon the angle of air discharge. In conclusion, Mr. Priester complimented the authors on the quality of the paper.

A. C. BARTLETT, Boston, Mass., stated that the average engineer was more in-

terested in obtaining an air flow from slots at right angle to the axis of the duct than he was in the pattern of the flow from a slot. Interest in the design of vanes for producing the desired type of flow or correct angle of discharge seemed more important than the determination of the flow pattern from slots without vanes.

MR. LEOPOLD recognized the value of information on the behavior of air streams in a room of infinite size as a theoretical background for further developments. He felt that sufficient data were now available on the theoretical behavior of air streams in an infinite room so that attention should now be devoted to the problem of distributing air in a finite room with a limited ceiling height.

W. B. HARRIS, New York, N. Y., remarked that in the paper, velocity was assumed to be essentially uniform from one end of the slot to the other. He inquired whether there was a great variation in velocity from one end of the slot to the other as the velocity increased or decreased. Also, he asked what was the minimum ratio of slot to duct area which would give essentially uniform air distribution.

W. C. L. HEMEON, Pittsburgh, Pa., expressed the opinion that the work reported had been a logical beginning, and that practical application to small rooms was indicated for future tests.

R. D. MADISON, Buffalo, N. Y., expressed agreement with Mr. Hemeon's remarks. He also noted that the paper emphasized the point that air does not flow straight out from openings, and felt that from now on attention should be directed to the problem of obtaining air flow in outlets at right angles to the axis of the duct.

MR. STACEY cited his experience with a slot 80 ft long and 1 in. wide, and stated that his problem of obtaining correct distribution would have been somewhat easier if the information in the paper had been available at the time.

MR. KOESTEL, in replying to Mr. Priester, stated that Fig. 9 was a plot of end points from curves such as Fig. 8 obtained by dividing the final static pressure at end of duct by the total energy at duct entrance. Up to the present, no data had been obtained on throw of air from the slots tested, but some data might be obtainable from later tests.

Replying to Mr. Ashley, Mr. Koestel stated that Fig. 9 indicated the loss due to eddy currents rather than duct friction loss.

Referring to Mr. Bartlett's remarks, the author stated that he hoped to determine the proper shape and location of turning vanes to produce a discharge of air at right angles to the axis.

Replying to Mr. Harris, the author reported that there was a velocity loss due to eddy currents or conversion which was found to be about 5 to 10 percent. The magnitude of the velocity was fairly constant over the opening, but the direction changed along the slot.

At the request of Chairman Stacey, Ernest Szekely, Chairman of the TAC on Air Distribution and Air Friction, reviewed some of the work of the Committee leading to research such as that reported in the paper by Professor Helander, and as reported in that to be presented by the next author.

Friction Equivalents for Ducts

He introduced R. G. Huebscher, Cleveland, Ohio, who presented an abstract of his paper **Friction Equivalents for Round, Square and Rectangular Ducts** (published in the December 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

R. D. MADISON, Buffalo, N. Y., commented on the fine quality of the paper. He referred to its contents as fundamental data which would be useful in further work on friction loss in elbows and fittings, work which was contemplated by the TAC. For elbows and fittings it would be necessary to express the friction loss in velocity heads, as well as in equivalent feet of pipe or in pipe diameters.

R. S. LEIGH, Waterbury, Conn., stated that in his experience he had found that the relationship of equal friction for equal hydraulic diameter held for ducts carrying air and also for tubes carrying viscous material. He mentioned also that friction was related to mass flow.

KIRBY WALKER, Lafayette, Ind., emphasized that problems in heat transfer, fluid friction and Reynolds number would be simplified by using mass velocity instead of velocity.

MR. HUEBSCHER, referring to Mr. Leigh's remarks, stated that while mass velocity was used a great deal in heat transfer work, it was more difficult to grasp in relation to air conditioning and ventilation where cfm was easier to visualize.

Chairman Stacey called upon Cyril Tasker, Director of Research, who presented **A Summary of ASHVE Research in Air Distribution and Ventilation.** Mr. Tasker began his remarks by stating that he was going to review one phase of the Society Research Program and then presented the following report.

ASHVE Research in Air Distribution and Air Duct Friction

By Cyril Tasker,[1] Cleveland, Ohio

The chapter on air distribution in the HEATING, VENTILATING, AIR CONDITIONING GUIDE 1947 opens with this statement. "Correct air distribution contributes as much or more to the success of a forced air heating, ventilating, cooling or air conditioning system as does any other single factor. An air conditioning system may deliver the required quantity of conditioned air and still fail to give satisfactory room conditions because of poor air distribution."

A short while ago in a discussion of the ASHVE research program, a member of the Research Laboratory staff was told that Society research in air distribution was ten years behind the industry.

These two statements may perhaps be sufficient justification for us to review what has been done in this field by the Society during the past twenty years, and particularly what the Committee on Research has been sponsoring in recent years. We should also consider how best we can develop and carry through a program of research which will be of maximum value to the members of the Society and to the industry at large.

[1] Director of Research ASHVE Research Laboratory.

If Society research is so far behind that of the industry, how can we remedy the situation? If it is not, how was such an impression created? This review will have served its purpose if it results in action along two lines: (1) to encourage those with unpublished experimental data in their files to put them in such a form that they can be brought before the Society membership in the form of technical papers, (2) to encourage those who feel that Society research in this field could, to advantage, change its emphasis to make specific recommendations, through the Technical Advisory Committee on Air Distribution and Air Friction and the Committee on Research.

For most of the background material for this review I am indebted to my colleague H. B. Nottage, who also prepared the survey of research problems for the Technical Advisory Committee on Air Distribution and Air Friction.

Air Friction

Including the three presented today, 37 papers on air distribution and air friction have been presented before the Society in the past 20 years. All but

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10 of these have been research papers coming from the Laboratory or cooperating institutions.

Nine of the 37 have dealt with air friction in ducts and fittings. What do we find as we review the *state of the art* today? We have:

1. A friction chart for round duct which is in line with modern theoretical developments in fluid flow.
2. Satisfactory corrections to this chart for other than standard densities, viscosities, and pipe roughness.
3. Sound data on friction equivalents for round, square, and rectangular straight duct and on the rectangular equivalents of circular ducts.
4. Some data on pressure losses due to elbows in round and square ducts and on the effect of splitters and vanes in reducing these losses.

We do *not* find, however, generally accepted data on friction through most types of through-flow and branch offtake fittings but instead a wide variation in the values suggested in well-known textbooks and manuals.

Ten years ago, in presenting the paper entitled A Rational Method of Duct Design, Prof. Lorin G. Miller said, "It is hoped that those having data known to be authentic will present them and that properly equipped laboratories will supply that information needed to satisfy controversial views."

Within the last two or three years the Committee on Research has, by studies at the Laboratory, supplied authentic data on friction in straight duct. Are there by any chance equally sound data on fittings buried in the collective files of the industry? If so, how can we get them out so that everyone can use them and avoid having to use those factors of safety or ignorance which cover the unknowns in the published data?

If they are not available in the industry, should not the Committee on Research seek to make them available, and if so, on whom can it count to assist in developing these values? Such data are of value to everyone concerned with problems of air handling and distribution: the fan industry, the sheet metal industry, the makers of air conditioning, air handling, and air diffusing equipment, the consulting engineer and his designers, and not least the contractor who frequently encounters some difficulties in making the system, as designed, work satisfactorily.

Your Committee on Research has made a start. In the last two years it has spent over $8400 on these problems and is now equipped with the basic apparatus, instruments and an experienced staff to continue some of these studies. Counting on some industrial support, it has budgeted $4000 for studies in 1948. How much is accomplished in the next two years depends to a marked degree on your requests to the Committee and the support afforded this work from those most interested in the results.

Air Distribution

The 28 papers on air distribution have covered a wide range of interest, from the analysis of natural ventilation and the investigation of rates of air change, through air flow measurements at intake and discharge openings and grilles, to entrainment and jet pump action of air streams and the downward projection of heated air discussed today. Nineteen of these 28 are research papers; sixteen have resulted from cooperative research between the Society and engineering schools throughout the country. The names of L. E. Davies, then of Armour Institute of Technology; G. L. Larson and D. W. Nelson of the University of Wisconsin; A. P. Kratz of Illinois and G. L. Tuve of Case have appeared on many of these. Linn Helander of Kansas State College joins the ranks with his paper on the Downward Projection of Heated Air. The Society owes a debt to these men for the keen interest they displayed in these studies and the contributions they have made to the sum of our present knowledge.

If ASHVE research *is* 10 years behind the industry, we have been slow in not persuading those who have the facts and the supporting experimental data to place them before their fellow engineers and so improve the whole art of air distribution, for an art it still will be until we can resolve it into a science.

This is not the place for more than a brief review of the data published over the past 20 years. There have been no research papers presented before this group on natural ventilation for 15 years; we certainly do not know all there is to know on this aspect of air distribution.

Air flow from unit heaters was discussed by the late Thornton Lewis in 1926, and his paper, which evoked tremendous discussion, is particularly interesting in that it mentions problems then unsolved which remain unsolved today.

Logan Lewis said in 1928, "Much is yet to be learned about air distribution through research and experiment, as a very large part of our present knowledge is in the form of personal opinion." There is still too much of that, but we have made a number of important advances.

Discussion on all three papers presented by L. E. Davies in the measurement of the flow of air through registers and grilles emphasized the practical difficulties involved in making satisfactory field observations.

J. H. Van Alsburg, in 1935, pointed out the need for further fundamental research in air distribution and general air movement in rooms. Studies in distribution from side wall outlets, made by D. W. Nelson and others as cooperative research projects, emphasized the mechanisms of ventilation-jet flow and dispersion.

In 1939 and 1940 Prof. Tuve and his colleagues reported on the use of air-velocity meters and on measurements at intake and discharge openings and grilles. They stressed the need for accurate standardized calibration and discussed the need of application factors. The discussion on these papers attested to the importance of the measurement problem.

In 1942 Messrs. Tuve, Priester and Wright reported the results of their experimental studies on the entrainment and jet-pump action of air streams. The discussion stressed the need for further attention to an analytical attack on the jet problem. In a later (1944) paper on the control of air streams in large spaces, the same authors pointed out that problems of instrumentation were still needing attention.

Review

Looking back over these papers and trying to evaluate them as contributions to the study of air distribution it would appear that past research has covered either (*a*) qualitative studies of air movement and distribution under specific application conditions, or (*b*) experiments and semi-empirical theories (involving various approximations) dealing with the flow of air from supply outlets into spaces or from spaces into exhaust intakes. While these studies form part of the general development of engineering knowledge and the application of the air conditioning art, all through these papers runs the recommendation for *further study of the fundamentals of air distribution.*

What are some of the difficulties of these *further studies*?

A. *Experimental*—(1) The movement of air in a large space is fundamentally governed by the laws of *turbulence*. Experimental equipment and procedures to measure and analyze turbulent conditions are still in their infancy. (2) The complete range of air velocities and of the magnitudes of the forces encountered includes quantities which are so small that accurate measurement requires a sensitivity which has been difficult to obtain in practical, conventional instruments. Entirely new techniques must be applied to meet this problem. (3) A complete set of experimental data on turbulent motion in space (*i.e.* an air conditioned enclosure) would require a complete record of all components as they vary from point to point and with time. The introduction of instruments is limited by the fact that the instruments may destroy or distort the behavior which they seek to measure. A large array of instruments also brings tremendous detail in recording data. We must aim at simplification of measurement.

B. *Analytical*—(1) Although the fundamental equations of energy and

motion may be written in calculus notation, they cannot be solved in their complete form by conventional methods. Predictions of behavior have therefore been limited to idealized conditions using certain approximations. (2) The theory of turbulence is still inadequately developed.

Despite these difficulties, progress has been made in developing practical estimates covering the essential factors in some of the common cases of flow and jet behavior. Much of the past work is very valuable; more is needed, however, for progress is a matter of cumulative experience.

The ASHVE Research Program in Air Distribution

Last year the Technical Advisory Committee on Air Distribution and Air Friction, under Ernest Szekely, chairman, instigated a survey of research problems in the field of air distribution. The first step was to classify research topics involved in relation to the needs of practical design data. The summary chart of Table 1 presents the grouping of primary topics. Each entry in Table 1 is then the subject of a further breakdown into constituent topics. Numerous research programs may be drawn up to suit evident needs.

Society research in this field is being planned so as to make a maximum contribution towards the development of *design data* for distribution systems. The use of more extensive and accurate data in design and in construction will reflect a rapid benefit to the profession and win the approval of the client, who is both comfort and economy-conscious.

Proven experimental techniques and methods of analysis are the foundation of valid design data. These are our responsibilities; we cannot hedge on them. In air distribution painstaking experimentation must be placed above all else.

For the past twelve months work has been under way, at the Laboratory and at Case Institute of Technology under a special cooperative arrangement, on the problems of turbulence and ventilation jets.

As a preliminary to an experimental program a comprehensive survey and analysis of the literature on turbulence, jets, and important related phenomena is being undertaken by Mr. Nottage. We expect to present the results of these studies in the form of a Research Bulletin as well as to present some of the highlights in the form of papers before the Society.

The recommended general program covers:

1. Performance Observations for Various Isothermal Ventilation Supply Arrangements.

Tests to investigate flow rates, pressure drops, outlet-approach conditions, discharge-velocity patterns, discharge throws, different surroundings and types of outlets.

2. Studies of the Downblow of Heated and Cooled Air.

Tests to investigate blows, spreads, and different initial conditions in the stream.

3. Fundamental Studies of the Processes of Energy Dissipation and Heat Transfer in Turbulent, Nonisothermal Ventilation Jets.

Studies of turbulent processes, energy conversions, trajectories, jet throws, and a clarification of the fundamental concepts. Consideration of outlet design in relation to turbulence as a flow variable.

4. Air Distribution and Air Movement in a Panel-Heated Room.

Full-scale studies involving ventilation, heat transfer, and comfort. New techniques will need to be developed and applied.

Conclusion

This is an ambitious program but no more so than several research programs successfully tackled in the past by the ASHVE Committee on Research which have resulted in important additions to our knowledge and the development of sound physical constants and dependable design data. Members of the Technical Advisory Committee have this year revised the Guide Chapter on Air Distribution and in so doing indicated some of the gaps in our knowledge.

During the past two years the Committee on Research has spent about $6500 on air distribution studies plus about $5000 on studies concerned with process ventilation. It has budgeted about $7500 for air distribution studies in 1948, a sum which represents about 8 percent of the over-all budget. Wider industry support could be used with advantage to increase the amount of work that can be carried through in the year and so bring us more rapidly nearer our goal.

Table 1—Condensed Topical Classification for Air Distribution Design Data Problems

NATURE OF THE DISTRIBUTION REQUIREMENTS	NATURE OF THE DISTRIBUTION SYSTEM DESIGN PROBLEMS	
Needs to Be Met	*Flow Conditions and Processes in the Supply Air Stream*	*Behavior of Ventilation Supply Jets*
Health Comfort Safety Industrial processing Commodity Storage Over-all Economy	Type and location of ventilating or circulating units Location and form of supply outlets and nature of approach flow Arrangements for natural ventilation Multiple outlets and system balancing Noise and dust problems	Initial jet flow conditions and state of jet air Motion and dispersion of jets Influences of various surroundings on jet motion and dispersion Interaction of multiple jets and of supply and exhaust streams
Type of Space	*Nature of General Air Movements in Spaces*	*Behavior of Exhaust-Suction Flows*
For General Occupancy Industrial Storage Transportation	Forced and natural air movements in relation to form and contents of space concerned Influence of supply and exhaust outlet locations Influence of the air state and ventilation rate Influence of activity, heat sources, etc., within space	Type and location of ventilating or circulating units Location and form of exhaust outlets and nature of exhaust-suction flow. Special problems of industrial applications involving health and safety. Natural ventilation outlets, balance of natural and forced exhaust flows Combination exhaust and supply fittings

Discussion

A. C. BARTLETT Boston, Mass. (WRITTEN): There is no doubt in my mind but that some time and money could well be spent on research in connection with the flow of air in pipes and the discharge of air in rooms from various types of outlets.

The author states that we have a friction chart which is in line with modern theoretical developments in fluid flow, which is quite true, but I am wondering even if that information is entirely correct. The HEATING, VENTILATING, AIR CONDITIONING GUIDE 1939 to 1941, for instance, gave the friction loss in 100 ft of 40 in. diameter round pipe with a velocity of 2000 ft as 0.125 in. water gage or one velocity head loss in 60 diameters. In 1947 that value has been decreased to 0.11 in. water gage or one velocity head loss in 68 diameters. European engineers use a friction loss of 0.1 in. or one velocity head loss in 75 diameters. One manufacturer in 1922 published information using a friction loss of 0.111 in. or one velocity head in $67\frac{1}{2}$ diameters. In 1947, however, this manufacturer used a friction loss of 0.094 in. or one velocity head loss in 80 diameters. Obviously, some of these values must be wrong for a given pipe construction, at least.

It is also stated that we have satisfactory corrections for other than

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standard densities, viscosities and pipe roughness. However, I am wondering who can tell the difference between a rough pipe and a very rough pipe. It seems to me that roughness to be of any value must be stated in some function of the pipe diameter.

Experience, which we have had, with smooth concrete ducts, which I should imagine would be classed as rough ducts as compared with galvanized iron, indicates that in large concrete ducts there is but one velocity head loss in 70 diameters whereas the information given in THE GUIDE 1947 indicates a correction factor of 1.8 for very rough pipes, which is equivalent to a velocity head loss in every 37½ head diameters.

It is further stated that we have sound information on equivalent round and rectangular ducts. If that is a fact, I have no knowledge of that information and would like to know if that is sound information. The usual weakness in the conception of a round duct equivalent to a rectangular duct is the lack of coordination between the Reynolds number for the two different shapes. It should be realized that the Reynolds number is only applicable to geometrically similar shapes. How it can be applied to rectangular ducts of varying dimensions is somewhat beyond my conception.

It seems to me that there is ample room for a lot of research on this subject of air friction in pipes and air distribution. We know nothing about the effect of branch take-offs, for instance, particularly where the engineer puts in an adjustable splitter or damper to effect the required distribution.

A great deal of research could well be done also in my opinion on the proper flow of air on the intake side of the fan system. We have a lot of information, such as it is, about friction on the discharge side, but very little attention has been given to intake connections, inlet boxes and the effect of bringing the air to the inlet of a fan in a somewhat restricted manner. We know, for instance, that if air is brought to the fan intake with a whirling motion counter to the wheel rotation, there is an entirely different effect produced than when the air at the fan inlet is whirling in the same direction as the wheel rotates.

Considerably more research and information could be obtained on the effect of the kinematic viscosity from which we find that friction loss due to the flow of air in a pipe increases with temperature rather than decreases, as would be expected, that is to say, the friction loss in a pipe when handling air at 200 F is greater than when handling air at 70 F.

Suggestion has been made that a lot of this information could be obtained from manufacturers. However, it has been my experience that manufacturers of fan equipment are too busy trying to keep up on fans to do much research work on the question of distribution and pipe friction, etc. To be sure, we have to use those figures a great deal, but in using them, have to use certain factors of ignorance in making calculations and guarantees; and we would feel a whole lot better off if we had actual data on which we felt we could depend.

A great deal of research work could be done and might be useful on the flow of air from heaters, both horizontal and downblast, including the effect of varying temperature. There is a tendency on the part of manufacturers to use trained arrows and educated smoke pictures to show the flow of air from unit heaters, we, perhaps, being as guilty as any. However, you can realize that these illustrations, if founded on fact at all, are depicted for the most favorable conditions, and, no doubt, are somewhat misleading to some engineers.

I heartily agree with the paper that work should be done on all of the subjects suggested on in Table 1.

NATHAN FEDER, New York (WRITTEN): I wish to say that Mr. Tasker's itemizing of knowledge that we have gained in our field to date and what we have yet to learn, was remarkable in its honesty and bluntness. Mr. Tasker did not try to exaggerate the knowledge gained so far from research, instead he stressed the great need for combined efforts from all concerned in our industry for more factual data that would benefit us all. I am certain that his sincere request will be heard and answered.

As for myself, I feel that though we have made important gains in our design and application of air supply and distribution outlets, practically no definite data on recommended practice for design and location of return outlets exist to my knowledge.

As C. S. Leopold mentioned in a discussion of a previous paper on the Discharge of Air from a Long Slot by Alfred Koestel and G. L. Tuve, we are dealing with finite rooms in practice and therefore in conforming our research in air distribution to idealized conditions instead of actual, we may not make enough progress.

As a practical engineer, I would like to see research conducted on supply outlets in a definite room or space, also I would be greatly interested in obtaining definite data on the effect various locations of return air openings would have on air distribution. Also, it would be of value to have some studies of ceiling type of outlets, which are today more common in our design than side wall outlets.

W. O. HUEBNER, New York, N. Y. (WRITTEN): Mr. Tasker has given us an interesting survey of the work done in air distribution and air friction by the ASHVE and cooperating institutions. At the same time he has stressed the need for further study, especially of the problems in air distribution. He has indicated some of the difficulties encountered in the study of the fundamentals of this art and acquainted us with the program which the TAC on Air Distribution and Air Friction has drawn up under the chairmanship of Mr. Szekely.

One of the foremost difficulties in experimental research, as Mr. Tasker pointed out, is unsatisfactory instrumentation for measuring and analyzing turbulent air flow. We have suffered under this condition for years and finally, because nobody could provide the instruments needed, have developed non directional thermocouple anemometers and hot-wire anemometers ourselves. We have reason to assume that instruments of this type will help us considerably in our own experiments, because such instruments, if designed correctly, are not only simple to use, but also extremely sensitive and accurate.

There is also need for a practical method of visualizing air flow in air distribution systems. The two-dimensional methods, even complicated ones like the Schlieren-method, are not adaptable to our needs and a three-dimensional method does not exist. Smoke streams, especially the smoke produced by the mixture of potassium chlorate and powdered sugar, as recommended in THE GUIDE, are often employed successfully, also for photographic purposes, but they are not really a good substitute for an instrument or a method which would allow three-dimensional observation and analysis.

Mr. Tasker has asked for the development of design data for distribution systems, based on proven experimental techniques and methods of analysis. As far as methods of analysis are concerned, Mr. Tasker pointed out, that the necessary equations are rather complicated and that the predictions of the behavior of air streams have been *limited to idealized conditions using certain approximations.* Even in simplified form, they are a mathematician's delight, but of little value to the practical designer. It has been suggested to apply the theory of the turbulent mixing of jets as developed by Tollmien and extended by Kuethe and others to an idealized representative of a great many outlets. I believe with Professor Tuve that it is better *to use a method of experimental integration instead of carrying out an analysis of the mechanism of turbulent diffusion.* In my opinion, the experiments made by Professor Tuve at Case Institute of Technology and now Professor Helander's experiments at Kansas State University have given us more valuable information than most other investigations, though the valuable work done for the Society especially by Davies and Nelson should also be mentioned. We are now especially looking forward to the work undertaken by

Mr. Nottage, who has the necessary theoretical background for this work which practical engineers rarely possess.

I should like to bring out one point, however, which has already been mentioned in revising THE GUIDE, namely that the development of the theory so far has been confined to side wall outlets and that most of the experiments have dealt with side wall distribution. Research in ceiling distribution is therefore urgently needed and I propose to start with the simplest form of the practical ceiling outlet, the ordinary plaque. The formulation of laws governing the performance of such a unit, distributing air with a deflection of 90 degrees and a spread of 360 degrees would be a valuable step in the right direction. As has been pointed out before, such experiments should however not be confined to the discharge of air having the same temperature as the room because this condition is only seldom encountered in practical installations.

I doubt that the man who expressed his dissatisfaction with our research procedure is a specialist in air distribution for practical applications. In a field which is so extremely dependent on human reaction, industry will always have to devise new and ingenious solutions of its problems. These solutions may not always be based on a 100 percent perfect theory, and only on patient observations in the laboratory and the field.

R. P. WARREN, Buffalo, N. Y. (WRITTEN): This paper seems to summarize and describe the status of the Society's position in research in air distribution and air duct friction quite completely. It presents a rather complete background together with several alternate courses which can be followed.

With regard to air duct friction, we believe that adequate work, at least for some time to come, has been done on friction in straight ducts. The existing charts agree satisfactorily with experimental work and field tests so that designers do have sufficient references to fall back on. We also believe that considerable work can be done on the clarification of losses through fittings. An analysis of existing work should be made, along the same lines that D. K. Wright followed for duct friction[2]. Certain tests should then be made where the data are too divergent for satisfactory use.

In considering air distribution, Mr. Tasker invites our attention to the fact that the Society authors for many years have consistently recommended further study of the fundamentals of air distribution. Certainly more basic information on the effect of buoyance of air is imperative in any broad study of fundamentals. More work should be undertaken on jet pump action of air streams, particularly where a difference of density and temperature is involved. Possibly cooperation with Professor Folsom of the University of California would be helpful in this work.

Considerable mention is given to turbulence in this paper. Also, Mr. Tasker has made reference to the difficulties which have been encountered by those who have studied instrumentation. When we remember that the present instruments for measuring very low air velocities are nondirectional we believe that any fundamental studies undertaken on air distribution should be paralleled or should include further study of instrumentation.

In closing we would suggest that care be taken in outlining the program, to provide for spot research in the initial stages of the studies. By proceeding in this manner many dead ends and inconsequential results can be avoided, and the proper channels for more exhaustive investigation can then be charted.

HENRY SLEIK suggested that the general acceptance of overhead supply outlets made it logical to direct research toward obtaining the behavior of air streams from overhead circular diffusers. Up-to-date available information had been supplied largely by the manufacturers of such equipment. He felt that the industry would support the proposed research program.

MR. KERSHAW remarked that he had been engaged with Thornton Lewis in obtaining much elementary information which was still being used. He felt that industry was not 10 years ahead of the Society in fundamental research, but that it might be in regard to some data concerned chiefly with specific applications. He believed that engineers in industry would be willing to make available to the Society information which might be confidential, but which could be used to guide the committee in planning its program of research. He referred to the funds available for research from membership dues and recommended that the Research Laboratory's indebtedness be liquidated in order to have more funds available for research.

WILLIAM WALLACE, II, Durham, N. C., suggested that information is needed in regard to friction in take-offs and elbows. He stated that the current elbow friction chart published in THE GUIDE contained one curve showing friction equivalents obtained by P. W. Bennett[3] in 1915. It was obvious that a checkup of the accuracy of the values shown by this curve would be desirable.

MR. ASHLEY listed the following gaps which should be filled in the present knowledge of air distribution: 1. The velocity and size relationship of free openings equivalent to various types of outlet grilles; 2. The effect of return flow velocity of primary and induced air on total induction and throw of a side wall outlet in a specific room; 3. Permissible range of terminal air velocity in a stream from a side wall or ceiling outlet; 4. The effect of heating and cooling on air discharged from a side wall outlet; 5. The effect of fanning of the outlet streams on performance; 6. Problems due to interference of air streams from multiple outlets; 7. The effect of air distribution across a smooth ceiling on the induction, throw and drop of isothermal and cooled air streams from side wall and ceiling outlets; 8. Means of take-off from distributing ducts to side wall outlets required for production of uniform flow of velocity from outlets; 9. The characteristics of ceiling distributors and panel outlets discharging free air along flat ceilings; and 10. Noise generation of outlets in different types and (for duct work) the effect of branch take-off on loss of energy conversion in the main stream.

W. L. FLEISHER, New York, N. Y., stated that the program outlined by the Research Laboratory would require about 50 years for completion, and therefore it would be advisable to limit the work to a phase of the investigation which would be of most interest. He suggested that research should take current trends into account, and mentioned as a current trend the practice of using smaller ducts and friction loss above 0.1 in. in large installations which handle hundreds of thousands of cfm of air. Research should be concerned with higher pressures regardless of horsepower since, in large installations, the refrigeration horsepower requirements might be five to eight times the horsepower required to distribute the air.

MR. TASKER, referring to the comments made, requested that they be put in writing for the benefit of the Technical Advisory Committee. He also suggested that verbal comments could be made to Mr. Nottage of the Laboratory staff. Mr. Tasker remarked that Laboratory income of $72,400 in the past year had been from dues, general Society funds, and the exposition, and contributions from industry.

He stated that the income from dues for the coming year was expected to equal $40,000.00 and that the research program had been established on the assumption of a $100,000.00 budget which was to be supported largely by the industry.

Chairman Stacey thanked Mr. Tasker and the other authors who had taken part in the meeting. Following a number of announce-

[2]ASHVE RESEARCH REPORT No. 1280—A New Friction Chart for Round Ducts, by D. K. Wright, Jr. (ASHVE TRANSACTIONS, Vol. 51, 1945, p. 303.)

[3]American Blower Co., Detroit, Mich.

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ments, the meeting was adjourned at 12:45 P.M.

Third Session—Tuesday, February 3, 2:00 p.m.

Chairman G. L. Tuve called the third session to order at 2:00 p.m. and requested that as a token of esteem for two distinguished members, W. T. Jones, Boston, Mass., and J. H. Walker, Detroit, Mich., who had died during the year, the members rise and observe a moment of silent reverence.

The Chairman stated that the session would be devoted largely to panel heating. He called upon G. D. Winans, chairman of the TAC on Panel Heating and Cooling, who presented the following:

Panel Heating Research Program

By Glen D. Winans,[4] Detroit, Mich.

It is unusual for a Technical Advisory Committee to make a report at the Annual Meeting of the Society. Reports of Technical Advisory Committees are made to the Committee on Research.

The importance of the subject was thought to warrant a departure from the usual. I am pleased to make this report of the Technical Advisory Committee on Panel Heating and Cooling at a session devoted to the subject of panel heating.

At the 53rd Annual Meeting in Cleveland, January 1947, a great deal of interest was shown in panel heating and, where panel heating is the subject of Chapter meetings, overflow crowds are attracted. A call was sent out for a panel heating conference to be held at the ASHVE Laboratory in Cleveland on March 7, 1947. There were 110 persons representing trade associations, technical societies, manufacturers, government agencies, colleges, and universities who attended this meeting. Many of you were at that meeting. Prof. G. L. Tuve presided at this session. It was the consensus of this meeting that the information on panel heating was in a very confused state, and it was the obligation of the ASHVE to undertake basic research on panel heating. The meeting approved a committee of representative groups to be known as the Technical Advisory Committee on Panel Heating and Cooling. This group was instructed to review the literature, to list all problems requiring solutions, and to break the problems down into its various phases. This Technical Advisory Committee was appointed in May and consisted of: A. B. Algren, R. L. Byers, Peter B. Gordon, L. N. Hunter, John James, J. S. Locke, H. F. Randolph and myself, as chairman.

On June 30 this Committee held its first committee meeting at the Laboratory. The scope of this Committee was outlined as follows: "To obtain data that will permit the proper calculation and design of panel heating and cooling systems, with the present emphasis being on applications for human comfort." The Committee then considered the outline of a research program prepared tentatively by the Research Laboratory. The overall problem is complex, and a breakdown was necessary to resolve it into less complex problems which lend themselves more readily to the analytical approach and to experimental investigation. For this reason the problem was divided into four parts, and it was proposed that the Committee consist of the Steering Committee and of four Groups A, B, C, D, to study the four subdivisions, which are:

Group A—Heat Distribution Within and Behind the Panel

1. Type, size, and spacing of conductors.
2. Physical, chemical, and thermal properties of the materials composing the panel.
3. Temperature of the medium.
4. Heat flow between the working medium and panel surface.
5. Relation of insulation to panel performance. Study of losses (edge, ground, reverse flow).

Group B—Heat Transfer Between the Panel and the Space

1. Temperatures of the panel surface and the thermal characteristics of the surrounding surfaces and the air.
2. Absorptivity of the panel and the surrounding surfaces.
3. Position of the panel (floor, wall, or ceiling) and its effect on convection and radiant release.
4. Shape of the space.
5. Panel covering and space furnishings.
6. Relative humidity and ventilation rates.

Group C—Comfort Conditions

1. The influence of radiation on the Effective Temperature Index in the comfort zone.
2. The influence of humidity on comfort in radiant heating installations.
3. The relation of panel surface temperature to comfort.

Group D—Controls

Investigate the different forms of controls best suited to various types of buildings and panel construction by field surveys, tests in buildings, and analytical methods.

The Steering Committee again met on August 11 and at that meeting reviewed the problem and selected key men in the industry to serve on this Committee to study the four assigned problems.

These men selected to serve are:

Group A—L. N. Hunter, *Chairman*; P. B. Gordon, *Vice Chairman*; A. B. Algren, R. A. Biggs, Wharton Clay, R. S. Dill, H. L. Flodin, Dr. F. E. Giesecke, W. S. Harris, C. F. Kayan, G. D. Lain, R. S. Leigh, C. W. Meininger, D. L. Mills, C. W. Nessell, P. S. Park, S. I. Rottmayer, S. M. Van Kirk, L. H. Yeager, (C. E. Abbey, *Alternate*).

Group B—John James, *Chairman*; H. F. Randolph, *Vice Chairman*; C. M. Ashley, J. T. Bergen, C. F. Boester, Linn Helander, A. L. Jaros, Jr., H. A. Lockhart, C. O. Mackey, R. A. Miller, G. W. Penney, G. G. Sward, J. M. van Nieukerken.

Group C—Not appointed.

Group D—J. S. Locke, *Chairman*; A. B. Algren, H. W. Alyea, S. D. Browne, R. L. Campbell, C. M. Garner, P. B. Gordon, W. J. Hajek, A. J. Keating, Dr. Waldo Kliever, H. T. Kucera, P. F. Neess, R. S. Penn, J. K. M. Pryke, E. J. Ritchie, C. W. Signor, N. D. Skinner, A. S. Widdowfield.

While the overall research program on panel heating and cooling has been broken down into four main divisions, none is wholly independent of the others but any one may be carried on as a separate research project.

Though separate groups will be responsible for each part of the program, the overall program will remain under the control of a steering committee, and further, there is overlapping of membership between the groups.

A meeting was held on November 5 of Group A and at this meeting was approved the program outlined in detail by the Research Laboratory staff. The main purpose of this group is to investigate the heat flow between the medium and the panel surfaces (concrete, plaster, or any other type) as influenced by the type, size, and spacing of conductors; the properties of the materials composing the panel; and the temperature of the heating or cooling medium. The relation of insulation, coverings, etc. on heat distribution and a study of edge and other losses form part of this investigation.

Though much of the experimental work will be carried on at the ASHVE Research Laboratory, this group will keep in close touch with all other studies having a bearing on this part of the problem that are under way at engineering colleges or in the research laboratories or test houses of interested organizations.

Group B met on December 1 at Cleveland under the chairmanship of John James. This group is to concern itself with *Heat Transfer Between the*

[4]Chairman, ASHVE Research Technical Advisory Committee on Panel Heating and Cooling.

Panel and the Space. These studies will cover the influence of such factors as the temperatures of the panel surfaces and the thermal characteristics of the surrounding surfaces and the air; the absorptivity of the panel and surrounding surfaces; the position of the panel and its effect on convection and radiation release; and the shape of the space and its furnishings. The part played by the relative humidity of the atmospheric environment and the rate of ventilation in the space will enter into these studies.

Much of this investigation can be carried on in specially designed rooms where adequate control of all environmental conditions, particularly surface temperatures, will be possible. Results from the experimental work of Group A will assist in setting the conditions under which work for Group B will be carried on.

Group C, Comfort Conditions. This group will study primarily the effect of radiation within the winter and summer comfort zones; the influence of humidity on comfort where panel heating or cooling is being used; the relation of panel surface temperatures to comfort.

These studies will also require rooms in which careful control of all environmental conditions is possible. Some of them can be run concurrently with studies under Group B or as a supplement to them.

There have been no appointments to this Committee as yet.

Group D, Controls. This group met in Chicago on December 17 and discussed its part of the problem. This group will concern itself with the investigation of the various forms of controls best suited to various types of buildings and panel construction. This will be done by field surveys, actual tests in buildings, and by analytical methods. It will also depend to a considerable extent on the results found in the studies under Groups A and B.

The problem was divided into four groups with at least one member of the Steering Committee on each of the groups so that the efforts of all groups would be coordinated.

The division of the problem can be questioned but this is the approach selected and, if carried out as planned, will result in clearing up much of the confusion in the industry about panel heating.

This program is a large one and of great importance to the ASHVE. Much of the work probably will be done at the Laboratory and, of necessity, some will be cooperative research with others.

One of the wonderful things about this Society is the amount of time put in by capable men for Society work. As you have heard, the men on these committees have all given very freely of their time and money. Three of the groups are actively at work. The Committee on Research has approved the program and has begun work in constructing the panels.

I am thankful for the opportunity of serving on this Committee, and I wish to thank all of the committeemen, the Laboratory staff, and others, for their cooperation with the Committee.

L. N. HUNTER, Johnstown, Pa., chairman of the subcommittee for Group A, outlined the test work planned by the committee for Group A *Heat Distribution Within and Behind the Panel.*

A critical survey had been made by the Laboratory staff reviewing all known published data on heat output of concrete and plaster panels using ferrous and nonferrous pipe. This survey showed that under identical conditions of pipe size, spacing, depth of cover and water temperature, stated heat outputs varied over a wide range.

Mr. Hunter stated that the proposed program was to determine experimentally the heat distribution within and behind concrete plaster panels as influenced by type, size and spacing of conductors, depth of covering, properties of the material composing the panel, temperature of the heating medium and the type and thickness of the covering or insulation above and below the panel surface.

Concurrently with the experimental program, analysis will be made of the heat flow in the panels tested in an attempt to develop an analytical method of predicting panel performance. Such a method if it can be developed will reduce the number of tests which would otherwise be necessary.

The first part of the program consists of building and testing specified designs of test panels or slabs. The first three panels will each be 6 sq ft. Two of the panels will contain ¾ in. nominal copper tubes on 4 in. centers and the third panel will contain ¾ in. iron pipe on 4 in. centers. The depth of cover above and below the tubes is as follows.

Panel Number	Tube Size & Material	Top Cover in Inches	Bottom Cover in Inches
1	¾ in. copper	3½	5
2	¾ in. copper	2½	2½
3	¾ in. iron	1½	4

Each slab thus constitutes two panels, each having a different depth of cover over the tubes. Since panels 1 and 2 have identical tube size and spacing, tests should give data on the effect of depth of cover over the tubes. When this information is developed, it may be necessary to construct and test only one panel for each other tube size and type.

The tubes will be so connected to the headers that any or all of them can be used at will. A single panel will, therefore, permit tests on 4 in., 8 in., 12 in., and 16 in. tube centers.

Heat Absorber Plates

The heat from each side of the test panel will be picked up by absorbers. These absorbers are constructed of refrigerated cooler plates. Each absorber will cover a test area of 4 ft x 4 ft or 16 sq ft and will be surrounded by four additional guard plates to control edge losses around the test area. Absorber and guard plates will be well insulated.

Heat Flow Meters

Heat absorption is to be measured by a number of small heat flow meters located under the absorber plates. The results obtained will be checked by measurement of the quantity of water circulated through each absorber and its temperature rise.

Test Procedure

No. 1 panel is being completed and tested first and additional slabs will not be constructed until we have had some experience in testing panel No. 1 to determine proper operating technique and prove the feasibility of the equipment and the proposed method of test. Tests on panels No. 2 and No. 3 will probably follow concurrently so that data can be obtained both on the copper tubing and iron pipe at the same time.

Observations

Panel surface temperatures, temperatures within the slabs, and those at the inlet and outlet of the fluid circuits of the slabs and of the absorbers will be measured by thermocouples. The first test on panel No. 1 with ¾ in. tubing will be on 4 in. centers with 3½ in. cover on top and 5 in. on the bottom and with average panel surface temperatures: 65 F, 75 F, 85 F, 95 F, 110 F, 125 F, 140 F.

Tests with 8 in., 12 in., and 16 in. centers will follow.

It may be advisable to turn the first panel over and take a few check measurements with the 5 in. cover on top and the 3½ in. cover below.

Effects of Insulation

It is planned to study the effect of insulation in reducing heat flow from the back of a concrete panel with equipment and panels just described.

Covered Slabs

Depending on the results obtained with these bare panels, it is proposed to make tests with one or more of these panels having the upper surface covered with (*a*) Linoleum and or asphalt tile; (*b*) Wood parquet flooring;

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(*c*) Carpet; (*d*) Wooden sleepers and wooden floor.

Mr. Hunter stated that the committee will welcome comments and criticisms of this proposed program. These criticisms may be mailed directly to the Laboratory or directed to one of the members of the committee.

JOHN JAMES, Cleveland, Ohio, chairman of the subcommittee for Group B, *Heat Transfer Between the Panel and the Space*, described the proposed test room 12 x 18 x 9 ft high so constructed that a division panel could be moved to obtain a room having a length of 9, 12, 15 or 18 ft. Mr. James explained that the ceiling, floor, or one to three walls could be operated as heated panels. By this arrangement the interior unheated surfaces could be maintained at temperatures corresponding to those existing for any given inside-outside temperature combination for any assumed number of exposed walls. Cold window temperatures could also be simulated. Electrically heated panels might also be used in some experiments.

In planning the equipment, arrangements were to be included for obtaining any desired number of air changes. At a later date it was expected that the character of the surfaces would be varied and also that furniture would be placed in the room to simulate occupied room conditions.

J. S. LOCKE, Minneapolis, Minn., chairman of the sub-committee for Group D on *Controls*, stated that the Committee originally planned to study: (1) heat storage and cyclic effects; (2) intermittent *vs.* continuous heating; and (3) load anticipating controls.

Some of the subjects which had been discussed at a meeting of the Committee were: (1) effects of low temperature radiation on conventional thermostats and other instruments; (2) heat storage effects on controllability; (3) on-off *vs.* continuous flow of heating medium; (4) location of controls—inside, outside or both; (5) how a combination panel heating or cooling and ventilating system should be controlled; (6) whether there is an uncontrollable system, and if so, how it can be defined; (7) whether lowered night temperature control is desirable.

The Committee felt that it should attempt to study controllability for all types of heating mediums, and also study the effect of heat storage and temperature lag in various types of panels.

It was also obvious that experimental data were needed for buildings having large and small glass areas, and that different types of building construction, light and heavy, should also be considered.

The Committee concluded that it would be necessary to test all combinations of light and heavy panels, large and small glass areas, and various combinations of these in buildings. The problem was also complicated by the number of methods that could be used for controlling systems.

The Committee also discussed the possibility of reducing the amount of test work required by using an analytical mathematical approach to the problem and it is expected that some of the analytical studies already begun may make it possible to select only certain experimental test insulations in which the analytical method can be checked against test data. The Committee believed that the amount of work under consideration would make it necessary to add an engineer to the Laboratory staff for the purpose of coordinating the analytical studies with the tests, and to insure that all tests conducted at various cooperating institutions would be made on a standard basis. The work which the Committee had considered seemed to require an expenditure of approximately $25,000.00 for the first year.

J. S. Kearney, Evanston, Ill., presented the Society with a check for $1,000.00 from the *Heating, Piping and Air Conditioning Contractors Chicago Association*, and stated that it was given without any stipulations regarding its use by the Society. He offered the cooperation of the Chicago association if the Society wished to make tests of a panel heating system of radical design recently installed in Chicago.

Chairman Tuve thanked Mr. Kearney in the name of the Society for his generous contribution.

Periodic Heat Flow, Panel Heating Air Temperature Gradients Discussed

R. G. Vanderweil, New York, N. Y., reviewed the history of panel heating and remarked that many systems of empirical design had been in operation 30 years. He traced the attempt to obtain a more scientific approach to panel heating design and stated that instead of elaborate computations he advocated a simplified method using charts he had prepared because it would yield results within 5 to 10 percent of the actual output. He then presented an abstract of the paper, **Measurement of Heat Output of a One Square Foot Panel**, by R. S. Leigh, Waterbury, Conn., and R. G. Vanderweil (published in the February 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Y. S. TOULOUKIAN, West Lafayette, Ind., inquired whether the three percent heat loss from the insulated side of the panel applied to all panel temperatures.

CHAIRMAN TUVE asked the author to explain further the method of determining the mean effective temperature.

J. B. FULLMAN, New York, N. Y., referred to the method of figuring room heat loss and asked whether a conventional method was used. He also asked how infiltration was figured.

C. M. HUMPHREYS, Cleveland, Ohio, pointed out that the effect of convection upon a small panel would be less than on a large one and that therefore the results were reported for a panel on which the convection effect was minimum.

P. S. PARK, Pittsburgh, Pa., expressed an opinion that differences between calculated and actual results obtained in installations were due to presence of furnishings or equipment within occupied space. He had also found that convection factors were frequently totally ignored, and referred to one case in which the output from the panel heated floor became different from still air conditions when an outside wind change produced a change in the amount of infiltration and probably thereby affected the heat removed by convection.

MR. VANDERWEIL, replying to Mr. Touloukian, stated that a value of 3 percent heat loss from insulated side of panel was approximately right for all panel temperatures.

To Chairman Tuve he remarked that since the panel was small the author had used some judgment in estimating the area of the cold surface which the panel could see.

Answering Mr. Fullman, the author stated that the heat loss from the room was not measured.

MR. LEIGH in referring to Mr. Humphrey's remarks, stated that convection may have affected the output 10 percent, but he did not think the effect was greater than this. He did not believe that convection effects would be serious except in buildings having a large amount of air blowing across the panels.

In the tests conducted, reflective insulation had been used on the side of the test panel to prevent convection effect, and to insure that the greatest effect on the panel would be that due to the walls above and on one side of the panel.

Chairman Tuve then called upon B. W. Levy, who presented an abstract of the paper, **Air Temperature Gradients in a Panel Heated Room**, by J. M. Ayres and B. W. Levy, La-

fayette, Ind. (published in the October 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

P. R. ACHENBACH, Washington, D. C., asked whether the test room was considered comfortable when the air temperature was 67 F at the 5 ft level.

CHAIRMAN TUVE suggested that authors comment on the difference between thermocouples and thermometers for determining temperatures.

WILLIAM M. WALLACE, II, Durham, N. C., inquired about the method of determining the air velocity shown in Fig. 9.

JOHN G. LEWIS, Kansas City, Mo., asked whether the density of the concrete had been taken into account.

J. M. AYRES, replying to Mr. Achenbach, stated that the stand for measuring the gradient temperatures was located practically in the center of the room. He stated also that at a temperature of 67 deg the room was comfortable for those running the tests.

Mr. Ayres was not certain whether gradient temperatures would change at points nearer to the wall surfaces, but stated that in another experiment it was found that at a distance of 1 ft from the wall there was very little effect of radiation upon the thermocouples.

To Mr. Wallace he stated that the velocity distribution was measured by a thermo-anemometer developed by Prof. C. P. Yaglou and operated in accordance with instructions supplied by him.

Replying to Mr. Lewis, Mr. Ayres stated that the concrete was composed of a lightweight aggregate of a density unknown to the author.

Chairman Tuve stated that the question of density and some of the others might have to be referred to the TAC on Panel Heating and Panel Cooling.

In introducing the next paper, Chairman Tuve stated that in heat transfer work engineers generally assumed equilibrium conditions which actually were not obtained in practice. He was therefore pleased to introduce the next author, Prof. H. A. Johnson, Berkeley, Calif., who would present a paper on periodic heat flow, referring to conditions which were actually obtained in practice.

Professor Johnson stated that published analyses of periodic heat transfer were subject to several restrictions because of the complexity of the problem, and that the paper to be presented was applicable only to the simplest situation—that of a homogeneous wall; composite walls, the effect of glass, or the variations due to transient effects, were not to be considered.

The author stated that a serious effort should be made to collect more information on sol-air temperature in order to further analytical studies of the type presented. He then presented an abstract of his paper, **Periodic Heat Transfer at the Inner Surface of a Homogeneous Wall** (to be published in the May 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

The meeting was adjourned at 4:40 p.m.

Fourth Session, Wednesday, February 4, 9:30 a.m.

Chairman L. P. Saunders called the fourth session to order at 9:30 a.m.

Heat Transmission Through Flat Glass

George V. Parmelee of the Research Laboratory stated that the paper about to be presented was a progress report in the Society's research on heat transfer through glass. He then presented an abstract of the paper, **Measurements of Solar Heat Transmission Through Flat Glass**, by Mr. Parmelee, W. W. Aubele and R. G. Huebscher, Cleveland, Ohio (published in the January 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Chairman Saunders in declaring the meeting open for discussion, remarked that in the research program to which the paper applied there was no previous work to copy and the method as well as some of the instruments had to be developed.

SAMUEL DUFFIELD, Gainesville, Fla., stated that some experimental research had been conducted on solar radiation and its application to water heaters at the University of Florida. He also remarked that some values reported differed from those given by Parry Moon.

CYRIL TASKER, Cleveland, Ohio, called attention to the development of the equipment at the Laboratory, and stated that he believed its reduced heat capacity would overcome some of the difficulties experienced with instruments used in previous solar heat research. While some had suggested that shading devices be tested immediately, it was felt necessary to complete tests first on plain unshaded glass of various types and on double glass. Tests on shading devices and glass block are expected to follow.

The apparatus used was also of value in collecting data on solar radiation and radiation exchange at night.

C. S. LEOPOLD, Philadelphia, Pa., mentioned the importance of determining what happened to the energy entering a room through the glass. Heat rays striking the floor would cause storage of heat. Also, Venetian blinds set at 45 to 50 deg would radiate to the ceiling where part would be absorbed and some reflected. In tests of shading devices, therefore, it was desirable to measure the proportion of heat reaching the floor, walls and ceiling. Mr. Leopold had found a great variation in heat balance of a room depending on the disposition of the heat.

R. A. MILLER, Pittsburgh, Pa., chairman of the TAC on Glass, referred to the wide representation on the Committee and mentioned that immediate testing of shading devices was omitted at first in order to obtain fundamental data upon which to base research work to follow. If the total heat can be measured by a fully absorptive body, and the distribution of the absorbed heat can be measured, it will be possible to learn how it is going to be distributed by various accessory materials.

Mr. Miller then said that glass blocks involving three different patterns, two of these in 8 in. and one in 12 in. size, were about to be tested. Some of the blocks to be tested will have built-in horizontal and vertical louvers. It is planned to keep the blocks stationary and measure the variation in heat transmitted as the sun travels from sunrise to sunset.

Nocturnal radiation will also be measured. It is expected that useful design data will be collected so that the program will be of value to engineers and all manufacturers of air conditioning equipment. All who can derive benefit from the program should therefore participate in it.

Human Response to Heat and Cold

Dr. D. H. K. Lee, Brisbane, Australia, presented an abstract of his paper, **Thermal Assessment of the Environment.** In this paper Dr. Lee made a proposal that the thermal significance of the atmosphere be determined by an equation expressing the relationship between the rate at which the atmosphere can accept heat and the rate at which the body is producing it. The applied thermal stress is given as the

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algebraic sum of the departure of metabolic rate and the rate of heat loss for the conditions prevailing at the point of thermal neutrality, from a point at which there is no thermal strain and no requirement for any adaptation on the part of a heat producing animal.

The suggested equation is of the form

$$y = x\left(1 - e^{-ax^2}\right)$$

where

y = general body strain
x = the thermal stress
a = a constant
e = Naperian base of logarithms = 2.718

Once the mathematical form is decided upon, the immediate practical problem is to determine constants for the equation for a defined set of conditions, either by experiment or by selection from the literature (as, for example, those proposed by the John B. Pierce Laboratory of Hygiene), and test the consistency between the calculated strain index and the physiological responses observed. If, when the responses of any one criterion are plotted against the calculated strain they fit on to a smooth curve, whatever its form, experimenters would be encouraged to proceed further with investigation. This would be essentially along two lines: first, establishing constants for a wide range of species, body form, or clothing; second, defining the tolerance limits of strain in terms of comfort, productivity, physiological integrity or survival.

C. P. YAGLOU, Boston, Mass. (WRITTEN): This is an excellent review of recent attempts to devise some index that would assess human response to heat and cold. From the standpoint of the average heating and air conditioning engineer, I believe that the paper would have served a more useful purpose if the author had confined himself to a discussion of difficulties involved in assessing thermal environments without injecting more philosophy into an already highly speculative subject which has confused the engineer so much.

Neither the thermal acceptance ratio, nor Dr. Lee's concept of thermal stress are applicable to comfort heating and cooling, even if it were possible to evaluate the constant involved, which it is not, at least for the present. The former is assumed to be an index of heat tolerance, *i.e.*, a ratio of the maximum heat stress that could be tolerated on exposure to extreme heat, to the strain imposed by heat and humidity, which is assumedly represented by the metabolic rate. Lee's formula refers to the strain that might be experienced on exposure to air conditions lying above or below the comfort zone. Within the comfort zone where metabolic rate and total heat loss remain constant, the strain index is 0, and this leaves us still at sea as to the relative importance to be attached to temperature, humidity, air movement and radiation.

Dr. Lee's concept may have future possibilities, but in its present theoretical stage it is likely to add to the confusion of engineers.

Dr. C.-E. A. Winslow, New Haven, Conn., presented a written discussion prepared by L. P. Herrington of the John B. Pierce Laboratory of Hygiene, New Haven, Conn.

L. P. HERRINGTON, New Haven, Conn. (WRITTEN): Dr. Lee emphasizes the fact that at present we have a large amount of information on human heat exchange but that this information is not sufficient to answer, in a convenient manner, questions on relative thermal stress which are frequent in the work of the ventilation engineer, the industrial hygienist, or physiologists and physicians concerned with public welfare. At the present time it is not at all difficult to specify environment conditions of air temperature, radiation, humidity, and air movement which will give approximate comfort for any combination of physical activity and clothing. This is the very considerable research achievement of the past 15 years. Why is it, then, that we need further research and particular attention to the specific proposals made by Dr. Lee? The answer to this lies in the term *relative thermal stress* and the distinction Dr. Lee has emphasized between linear increments of heat load in a purely physical sense, and the relatively physiological cost of meeting additional equal increments of physical load as the individual approaches his limit of tolerance.

Although we can now write the prescription relating clothing and activity to various heat loads in a reasonably accurate manner, we are not nearly so favorably situated when it is required that we estimate the relative physiological costs of such adaptations. Dr. Lee's proposal that we accept a tentative formulation of a curve relating physiological stress to physical heat load is entirely timely, and should be viewed with approval by research interests in this field. The reason for this is not the necessary accuracy of the proposed formulation, this is admittedly tentative. It depends rather upon the desirability of focusing attention upon the problem of stress interpretation of the data now available and being accumulated in the field of human heat exchange.

The situation is somewhat analogous to that which existed 15 years ago with reference to the problem of condensed generalized descriptions of the *Physical Factors*. Prior to a rather general recognition of the desirability of using established equations in heat transfer for the analysis of human heat balances, experiments on human adjustments were reported with widely varying scales of reference, and with frequent failure to control one or more of the four primary factors affecting heat balance. However, when the basic formulations were accepted the comparability of new work greatly increased and the first really significant advances toward a generalized solution of the problem were made. At the present time, publications primarily concerned with tolerance limits and the degrees of physiological cost associated with various exposures are usually uniform in their method of specifying the environment and analyzing the heat exchange. With regard to their primary end, however, the estimation of relative physiological stress, there is no systematic approach, certainly none involving any satisfactory hypothesis as to the quantitative relation between thermal load and bodily stress.

Dr. Lee has proposed as a further step the use of an index known as the *Thermal Acceptance Ratio*. This likewise seems a useful procedure. By placing a limit on tolerable skin temperature and limiting possible skin evaporation to a quantity consistent with saturated air at the temperature required to produce this limiting skin temperature (radiation being introduced as a corrective term), it is possible to utilize the basic constants of partitional calorimetry to define limiting atmospheric conditions. Earlier work has shown that the *Thermal Acceptance Ratio* bears a systematic relation to gross measures of thermal stress such as pulse increment and total sweat secretion, and its use in further work in combination with the proposed index of physiological stress is entirely constructive.

Referring to Professor Yaglou's discussion, Dr. Winslow expressed surprise at the position taken. He felt that Professor Yaglou's introduction of skin temperature in evaluation of comfort[5] emphasized a trend in the direction advocated by Dr. Lee.

It seemed clear that within the range in which the air conditioning engineer deals, discomfort on the cold side is accompanied by a fall in temperature and with the hot side is associated with additional sweat secretion. It would seem to be advantageous to substitute these definite, measurable factors for the vague conception of average comfort because they make it possible to deal with an individual with different clothing, different work load and different

[5] A Method for Improving the Effective Temperature Index, by C. P. Yaglou. (ASHVE JOURNAL SECTION, *Heating, Piping & Air Conditioning*, September, 1947.)

physical capacity. Dr. Lee's suggestion seemed, therefore, to present the logical step forward in understanding the true relation of atmospheric conditions to human comfort.

C. S. LEOPOLD, Philadelphia, Pa. (WRITTEN): Before undertaking work along the lines suggested by Dr. Lee, and I hope that we will, it would appear in order to examine carefully the basic assumptions and carefully to define all of the terms. For example, Dr. Lee, referring to the neutral point, states: "At this point no active vaso-constriction or vaso-dilation, no sweating, no variation in heat production is called for." I do not believe it is axiomatic that this would represent the point of minimum discomfort or maximum comfort as measured subjectively as it must be for ultimate validity. It is plausible that it should be so but it is equally plausible that some minor state of activity of the control factors would represent the point of maximum comfort. This refers to the individual. For a group it would appear likely that the average optimum point would be in the range where some compensation was employed because the null point would probably not be the same for all individuals in a group. As a minimum, we should carefully define the word *sweat*.

Dr. Lee also states that the stress strain curve which passes through zero should be symmetrical about the stress axis. Again, it seems that this assumption is not necessarily axiomatic for either the individual or for the group.

For both points it would appear that since these assumptions are so important in the final solution, the validity of the assumption should be checked before proceeding.

One other point could stand clarification. Dr. Lee states that . . . "the central practical objective of human climatology is to determine the effect a given climate may be expected to exercise upon the well-being of the individual." Basically, there is no quarrel with this point of view but in the region of little or no discomfort question has often been raised as to whether the environment which produced a maximum *feeling* of well-being coincided with the point of maximum well-being. There does not appear to be any real evidence of non-coincidence but the point has served to cloud many discussions and, if only for this reason, it rates clarification.

L. T. AVERY, Cleveland, Ohio, stated that the comfort zone as shown on the ASHVE Comfort Chart, disregards the strain due to adjustment. The comfort zone is called a zone of equal warmth. It seemed desirable to determine a health zone where the body is in its normal balance. It should be possible to determine such a zone to replace the present wide zone of comfort.

Mr. Avery also stated that radiant environment and availability of water for evaporation were factors which should be considered in establishing a health zone.

NATHANIEL GLICKMAN[6] and R. W. KEETON, M.D., Chicago, Ill. (JOINT DISCUSSION—WRITTEN): The author is to be commended for stimulating interest anew to quantitatively assess the ambient environment.

The thermal acceptance ratio, R_a, is another index defining the environment; effective temperature and operative temperature are two others. However, effective temperature omits radiation and operative temperature omits relative humidity while the thermal acceptance ratio includes both terms. As proposed, this equation gives no consideration to air velocity and it can be assumed that the equation applies only to conditions of still air. Should not the temperatures in the radiation component be expressed as absolute and to the fourth power?

As stated, when thermal acceptance (H_a) equals zero, the environment cannot accept heat from the organism and storage will occur. The organism would be unable to survive long in this environment. Further, when the thermal acceptance ratio (R_a) is less than 1.0, storage will occur and survival time of the organisms will be reduced. It is difficult to state, without any experimental data, at what value above 1.0 negative storage (body cooling) will occur. Further it would be important to know whether the thermal acceptance ratio (R_a) applies to both equilibrium and dynamic situations.

It would appear that the thermal acceptance ratio could be correlated with sensations of warmth or coolness. Has the author made such studies?

The equation assumes an average value for the wall temperatures and therefore does not take into consideration directional effects. In other words, we may have a value for R_a which would be within the zone where no physiological strain was produced and still have a sensation of discomfort because of localized cooling or heating.

The question presents itself as to whether the effective temperature index modified to include radiation would correlate better with observed physiological strain than the thermal acceptance ratio. This could only be determined by actual experimentation.

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The equation expressing stress (S) states that stress is applied even in thermally equivalent environments within the zone of vasomotor regulation. Thus, any condition which causes a change in the mode of heat loss from that existing at the *neutral point* is considered as applying a stress. The term *neutral point* is sound mathematically, but would be most difficult to determine physiologically. Perhaps it would be better to use the term *neutral zone*.

It should be noted that the alterations in the way in which heat is lost are physiological and it is conceivable that a given environment may make the elimination of heat more difficult physiologically even though heat balance exists. The problem would seem to be one of measuring this degree of difficulty and assigning some quantitative values to these difficulties. This is essentially a problem in the field of physiology. The author states that the effect of stress near the *neutral point* will be small. This appears to be splitting hairs and it is difficult to visualize how a measurable physiological strain near this *point* could be determined if one existed.

Will the author describe his concept as to how the value for the various constants will be determined?

This paper will stimulate thought and action to arrive at a mathematical form which will adequately express the stress-strain relation so well outlined by Dr. Lee. It would seem that this should and could be done and, simultaneously, it should be possible to re-evaluate the effective temperature index including the factor of radiation.

DR. LEE, in reply, thanked Dr. Winslow, Mr. Leopold and Mr. Avery for suggestions which would be considered in planning further work on the thermal assessment of the environment. Referring to Mr. Glickman's comments, Dr. Lee stated that the idea of thermal acceptance ratio is still in the process of development.

Offers Improved Method for Testing, Rating Air Filters

R. S. Farr, Los Angeles, Calif., presented an abstract of the paper, **An Improved Test Method for Rating Air Filters** by R. S. Farr, W. N. Pauley and K. A. Crismon, M.D., Los Angeles, Calif. (published in the February 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

JOHN W. MARKERT, Washington, D. C. (WRITTEN): This paper deals with one of the most important problems of the industry. The lack of test code standardization mentioned by the authors has been a pet peeve of the writer.

In government work it is particularly difficult to obtain quality merchandise without a very complete specification covering material, design, and performance. With most air conditioning equipment this is not too difficult, because methods of testing have been de-

[6]Assistant Professor, College of Medicine, University of Illinois.

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veloped and accepted by the industry. This does not exist with respect to air filters all of which are almost perfect according to the manufacturer's advertised ratings. It is, therefore, essential, as the paper indicates, that an acceptable method be developed for analyzing the last 1/10th of 1 percent, which appears to be the only place where most filters *apparently* differ in performance.

The filter industry must get together and take this matter seriously enough to come to a working agreement rather than divide forces and prevent the formulation of a practical code. Unless they do this, they will have to abide by the opinions of individuals, which may be unintelligent, unfair and unscientific in many instances. Furthermore, such a code will accelerate research and permit the user to utilize more intelligently the skill of the industry.

As a representative of a large purchaser of air and grease filters, the writer has been totally discouraged by the inability of the industry to do just what this paper advocates. It took the Maritime Commission about five years to establish a satisfactory specification covering air filters, holding frames and maintenance equipment. During this time most air filter manufacturers had their products tested and rated. With the exception of one, all manufacturers had to modify or completely redesign their products to meet test requirements at considerable time and expense which was borne by the various manufacturers. The irony of the situation is that at the present time, less than a year after the final specification was perfected, the entire effort has proved to be a complete failure because the only laboratory set up to perform the tests is part of a Federal bureau, which now lacks funds and space for the work involved. This is embarrassing to say the least. The foregoing experience is probably typical.

The acceptance of a code equal to that recommended by the authors will improve the prestige of the industry. The writer has inspected the equipment described and discussed the subject with Mr. Farr. In conclusion it must be said that the sincerity of this effort is beyond question.

JOHN HOWATT, Chicago, Ill., referred to difficulties of establishing a test code for dust and mentioned two principal obstacles; a selection of the type of dust to be used and the method of measuring filter efficiency. Disagreement of manufacturers on the type of dust to be used was sometimes due to variation in performance of their respective filters with different dusts. Mr. Howatt believed the method presented in the paper would stimulate activity toward completion of an acceptable code.

MR. FARR stated that the test method proposed was not based on any one dust. Dusts vary in kind in any locality at different times during the year, and selection of one type of dust as a standard was therefore improbable. The authors did not believe the selection of one type of test dust to be practicable, and it was expected that any number of dusts or the actual dust collected in the field might be used after the test procedure had been agreed upon.

The work to date, according to the author, had not resulted in an agreement on method of evaluating the effectiveness, that is, whether the weight method, particle count or discoloration method should be used.

Report on Guide Committee Activities

R. S. Dill, Washington, D. C., chairman of the Guide Publication Committee for THE GUIDE 1948, presented a report of Committee activities. He referred to the freedom with which valuable technical information is made available in America, and paid tribute to the willingness of successful engineers to share their experiences in providing technical information. The progress of THE GUIDE is due to this willingness and cooperation on the part of members and other engineers.

Mr. Dill stated that the practice of appointing only one-third of the members of the Guide Committee each year should be continued in order to preserve continuity from year to year.

A record of the principal changes being made in the 1948 edition were then outlined as follows:

The arrangement of Chapters in THE GUIDE has been retained, except that a new chapter on Corrosion and Water Formed Deposits, Causes and Prevention, has been added as Chapter 51, and the Chapter on Codes and Standards has therefore been changed to number 52.

Heating Load; Cooling Load; and Estimating Fuel Consumption for Space Heating; these chapters have been improved by enlarging the Tables on Temperatures, Design Conditions and Degree Days, this information being secured from the U. S. Weather Bureau and the Canadian Air Services, Meteorological Division. Heating Load contains a new map showing Isotherms of outdoor temperature. Design Temperatures in common use are tabulated for many localities. Cooling Load was completely rewritten and enlarged to 45 pages in order to improve the information on effect of solar heat transmission and periodic heat flow, and to simplify the design of cooling systems.

The Air Distribution chapter was completely revised by the ASHVE Technical Advisory Committee on Air Distribution and Air Friction. It contains new definitions of terms and formulas for air distribution. Charts have been included for graphical solutions of problems involving flow of air from slots and jets.

The chapter on Corrosion and Water Formed Deposits, Causes and Prevention, presents corrosion theory and also current practice in prevention of corrosion and scale and slime in heating, ventilating and air conditioning systems. The chapter was prepared by the ASHVE Technical Advisory Committee on Corrosion.

The Water Services chapter has been enlarged by the addition of a Friction and Capacity Chart applicable to copper tubing. The Charts for both standard I.P.S. Piping and Copper Tubing have been extended to small capacities, and can be used for calculating friction loss for panel heating installations.

Automatic Control—this chapter was rewritten to include more detailed treatment of typical controls and control combinations for all types of systems.

Instruments and Measurements—this chapter has been improved by the addition of descriptions of a greater number of instruments and their use.

The Codes and Standards chapter includes several new Codes applying to heating, ventilating and air conditioning, as well as revised references to the latest editions of all Codes listed.

In the chapter on Air Contaminants the permissible limits for toxic gases, vapors, fumes, mists and dusts have been revised to agree with recent conclusions of industrial hygienists.

Various chapters have been rearranged or revised for the purpose of keeping the chapters up to date or facilitating the use of the information given. Among such chapters are Gravity Warm Air Systems, Steam Heating Systems and Piping, Unit Heaters, Unit Ventilators, Unit Humidifiers, Spray Apparatus, Central Systems for Air Conditioning, Industrial Air Conditioning, Drying Systems, Transportation Air Conditioning.

The chapter on Fans has been improved by the addition of typical sound level curves to the fan performance curves. A new diagram has been included to show accepted designations of direction of rotation and discharge for fans.

By concentration or simplification of material, it has been possible to add a new chapter without adding to the number of pages in THE GUIDE. Mr. Dill stated that in addition to the work that had been done in preparing the 1948 edition, the committee had arranged for the beginning of work on revision of other chapters such as those on Thermodynamics and Panel Heating and Radiant Heating, and that results of this work might be evident in future editions.

Mr. Dill referred to the great amount of work required in preparing THE GUIDE, and expressed his appreciation of the very able and active committee composed of Messrs. R. L. Byers, R. P. Cook, R. C. Cross, B. H. Jennings, C. F. Kayan, W. M. Wallace, II, W. N. Witheridge, C. P. Yaglou, Cyril Tasker, Ex-officio member, and Carl H. Flink, Technical Secretary.

William M. Wallace, II, Durham, N. C., at the request of Mr. Dill, gave additional information on the enlarged tables of weather data provided in the Guide chapters on Heating Load, Cooling Load and Estimating Fuel Con-

sumption for Space Heating. He reported that data for airports were included where available. Elevations of the bulb of the station thermometer were given instead of the station elevation. In order to provide as much information as possible on weather design conditions, dry bulb and wet bulb temperatures in common use were obtained from ASHVE members or published tables, and shown in a separate column of design temperatures.

The session was adjourned at 12:10 P.M.

Fifth Session, February 4, 2:00 p.m.

Chairman G. L. Tuve called the meeting to order at 2:00 p.m. He stated that the Meetings Committee had planned the session around the single subject of the heat pump because present interest in its development and use had created a demand for information. Professor Tuve then requested L. T. Avery to take charge of the meeting.

Mr. Avery stated the purpose of the meeting was to bring out information regarding the heat pump which had attracted a great deal of interest because of the possibility of obtaining an efficiency of 400 percent or more. Five presentations of different phases of the subject were to be given, after which questions from the audience could be directed to the five speakers.

J. D. Kroeker, Portland, Ore., gave an abstract of the paper, **A Heat Pump in an Office Building,** by J. D. Kroeker and R. C. Chewning, Portland, Ore. (published in the March 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

W. E. Johnson, Bloomfield, N. J., presented his paper, **Economic and Technical Aspects of the Heat Pump** (published in the December 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Mr. Johnson emphasized three points in presenting the paper.

1. That acceptance of the packaged heat pump as distinguished from the apparatus type of heat pump depends primarily upon economic factors which are forcing consideration of certain technical problems. It is not the technical problems in themselves that are hindering development of the heat pump, but technical problems brought about by economic considerations.

2. That economic considerations are strongly influenced by the type of installation.

3. That strong factors in the marketing situation must be considered well by those interested.

Walter Herrman, New York, N. Y., presented the following discussion on Power to Operate These Heat Pumps.

Power to Operate These Heat Pumps

By Walter Herrman,[7] New York, N. Y.

As a representative of the utility industry, it was appropriate that your chairman should assign to me the discussion of power supply as it affects the utilization of the heat pump. Next to a source of heat, it is apparent that the availability of ample electric energy, at prices which will permit of operation reasonably competitive with fuel-fired plants, is a most important prerequisite. What then, are the factors involved in this connection?

The question of availability of power is almost academic. While a minor power shortage exists at the present time, new generating capacity planned for installation in the next two years should adequately provide for any foreseeable increase in demand attributable to the heat pump. Neither is there any expected problem in respect to local distribution facilities. While a concentration of heat pumps in any given area may require rebuilding of circuits and increased transformer capacities, these changes are normally routine. However, in the event the size of individual units should be increased above say 5 hp, with an accompanying change to three-phase motors, a considerable problem might arise. At present three-phase supply is available in only a very limited percentage of residential territory and to bring such service into these areas would ordinarily be uneconomic except for a very substantial load. Presumably the best answer to this problem is the use of multiple single-phase motor-compressor units.

Economic Availability of Power Is Vital Question

The really vital question in connection with power supply is price. Price in turn depends in most instances on two other major variables—the cost of coal and the load factor. However, since the cost of coal also influences to a large extent the cost of competitive heating, this factor tends to cancel. Assuming an overall thermal efficiency of the utility system of 25 percent from boilers to the customers' premises, and a coefficient of performance (cop) of 4 to 1 for the heat pump, it is obvious that the Btu delivered by the heat pump would be exactly equal to the Btu of the heat energy contained in the coal burned at the power house. But since the delivered cost of coal by the carload or shipload will ordinarily run only 30 to 40 percent of the cost in small lots to the householder, and since the boiler efficiency of the utility company is higher than that of a home furnace, the fuel component in the energy cost of operating a heat pump is reduced accordingly. On the other hand, operating expenses and taxes incurred by the utility at least partially offset these savings.

In an average utility steam plant system, the fuel component of the energy cost will range from about 2 mills to 6 mills per kwh which would correspond roughly to coal at $3 a ton and $9 a ton respectively. If this energy is utilized in a heat pump with a cop of 4 to 1, each kwh would produce useful heat at a rate of approximately 13,000 Btu per hour. By contrast, if 14,000 Btu coal costs $10 a ton or a half cent a pound delivered to the householder and is burned at 60 percent efficiency, the cost of 14,000 Btu delivered heat would be about 8 mills and at $20 a ton the corresponding cost would be 16 mills. Considering fuel costs only, therefore, the heat pump has a very apparent advantage.

Load Factor a Major Element in Cost of Service

Unfortunately, a more important element in the price of electric service is the cost associated with the large investment required to generate, transmit and distribute the energy. In a typical plant, this investment will now run about $400 per kilowatt of installed capacity, on which annual costs for maintenance, depreciation, interest and taxes, plus a return to the investor, will average from 12 to 15 percent. A conservative figure would be $50 per year per kw or about 5.7 mills per hour, assuming the consumer makes use of the service steadily for the entire 8760 hours in the year. If the service is used only half the time, the hourly cost is doubled and becomes 11.4 mills. At 25 percent load factor, the hourly cost is increased to 22.8 mills although these higher amounts would normally be reduced because of diversity between individual installations. Nevertheless, if energy costs are assumed to be 5 mills per kwh, which is a fairly good average at present prices of coal in this area, it is obvious that even at very high load factors it would be impossible to deliver power for domestic service for less than about 1.1¢ per kwh, whereas for poorer load factors the cost will rise above two cents. At the lower level, the probable cost of

[7] The Commonwealth & Southern Corp.

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operation of a heat pump should be very competitive with other forms of heating. In the upper range, the cost will undoubtedly be somewhat higher than for conventional heating. In each case, of course, the exact cop of the heat pump unit, as well as the kind of competitive fuels considered, will enter into the question.

All other things being equal, it seems apparent that in order to qualify for a minimum rate and a corresponding advantage over competitive fuel-fired furnaces, it is essential that heat pumps be designed and applied so as to operate at the highest possible load factor.

Temperature Characteristics Favor Auxiliary Heat Source

Attention is directed in this connection to the fact that in most parts of the country the winter temperature variations are such that about 90-95 percent of the total heating requirements occur above the average rate of demand, and about 5-10 percent below the average. In other words, assuming a 5 hp unit is required to take care of the coldest day, a 2½ hp unit would be large enough to supply 90-95 percent of the total seasonal requirements while the extra 2½ hp would be needed for only 5-10 percent of the energy supplied. This means of course, that if a heat pump is designed to satisfy the maximum demand half of the capacity of the unit will be idle a great proportion of the year, and the load factor will be correspondingly poor. If, however, it were possible to get along with a unit half as large, and make use of a storage system to furnish the relatively small amount of marginal heat required during the few peak days, the load factor could be improved accordingly. Further, if the heat pump itself could be used to charge the storage system when not otherwise in operation, a still greater improvement in load factor would be achieved. Obviously, from a thermal viewpoint, a 2 hp unit operating 24 hours per day will produce the same energy as a 4 hp unit operating 12 hours. The advantages of such a smaller system include not only a far better load factor and consequently lower rate for power, but a lower first cost and lesser space requirements for the equipment.

Many people have asked if it is feasible to operate the heat pump entirely off-peak so as to avoid all or substantially all of the capacity costs. In my personal opinion, off-peak operation is not practicable since this would require a unit large enough to take care of all direct heating during the off-peak hours plus as much or more capacity to charge the storage system. Such an arrangement would presumably involve doubling the size of the heat pump and the consequent demands on the utility company also would be increased accordingly. Further, since the storage system would have to supply approximately 12 hours of on-peak requirements, it too, would be considerably increased in size as compared to an arrangement in which it was used only as a supplement to the heat pump.

However, in spite of my reasoning to the contrary, I note that one of the larger companies in Ohio has recently filed a special rate of 1½ cents per kwhr applicable to off-peak water heating and year round heating and cooling using the heat pump. Service is provided 12 hours a day as selected by the utility. To my knowledge, this is so far the only rate in the United States established especially for heat pump use.

Existing Rates Will Govern Until Changes Indicated

For the time being, it is my belief that the great majority of utilities will serve heat pump installations at standard residential rates which usually do not take load factor into consideration. When, as and if the use of this device becomes sufficiently extensive and if it appears that the load factor justifies, special rates undoubtedly will be designed to suit. If on the other hand, an average load factor of say only 20-30 percent is obtained, many existing tariffs, particularly the low end blocks, may have to be increased.

Attention is directed in this connection, to Table 1 which sets forth typical *end* rates of 20 major utility systems in various states. Note that the lowest tariffs are in the south and west where cheap gas and hydro power are relatively abundant. The highest charge of 3 cents per kwhr is found in Boston, where all the energy is generated by high-priced coal. Since the pattern of these schedules tends to follow the local price of fuel, the competitive position of a heat pump is probably less pronounced than these price differentials would indicate, especially if future adjustments can be made in the rate levels along the lines indicated in the foregoing.

Table 1—Typical Follow-on Domestic Rates of Selected Electric Utilities

Name of Company	Territory Served	End Block of Domestic Rate
Alabama Power Company	Alabama	1c over 200 kwh (plus excess demand charge)
Arkansas Power & Light Co.	Arkansas	1.5c over 400 kwh
Boston Edison Company	Massachusetts	3c over 80 kwh
Commonwealth Edison Co.	Illinois (Chicago)	2c over 100 kwh
Cleveland Electric Illuminating Co.	Ohio	1.5c over 250 kwh
Consolidated Edison Co.	New York City	2c over 127 kwh (plus fuel charge adjustment)
Dallas Power & Light Co.	Texas	1.5 over 167 kwh (plus excess demand charge)
Detroit Edison Co.	Michigan	2c over 250 kwh
Duquesne Light Co.	Pennsylvania (Pittsburgh)	1.7c over 100 kwh
Florida Power and Light Co.	Florida (Miami)	1.5c over 180 kwh
Georgia Power Co.	Georgia	1c over 200 kwh (1.5c step per)
Hartford Electric Light Co.	Connecticut	1.5c over 265 kwh
Indianapolis Power & Light Co.	Indiana	2c over 120 kwh
Iowa Power and Light Co.	Iowa (Des Moines)	2c over 200 kwh
Kansas City Power & Light Co.	Missouri	2.5c over 30 kwh
Mississippi Power & Light Co.	Mississippi	1.5c over 510 kwh
New Orleans Public Service	Louisiana	1.5c over 500 kwh (plus excess demand charge)
Northwestern Electric Co.	Oregon (Portland)	7 mills from 225 to 1,125 kwh and 1c for excess
Pacific Gas and Electric Co.	California (Northern)	1c over 200 kwh
So. California Edison Co.	California (Southern)	1c over 285 kwh

Competitive Energy Costs Based on Other Fuels

After examining Table 1, the data in Table 2 will be of interest. It is taken from a report of R. A. Budenholzer, Professor of mechanical engineering, Illinois Institute of Technology, and shows the equivalent price of electric energy required for operation of a heat pump to balance certain assumed costs of fuel-fired heating under various operating conditions. Professor Budenholzer points out, in discussing this table, that the assumption of an overall motor-compressor efficiency of 70 percent is not yet realizable, but is probably a practical possibility. The evaporator temperatures shown are based on the use of a refrigerant coil buried in the earth below the frost line. Taking 30 F as an average evaporator temperature and 110 F as the condenser temperature, with coal, oil and gas prices and burning efficiency as indicated and a motor-compressor efficiency of 60 percent it will be noted that the corresponding equivalent costs for electric energy range from 1.02 cents to 1.29 cents per kwhr.

It is not known whether Professor Budenholzer reflected in these calculations the fact that a heat pump does not require air for combustion, which ordinarily tends to reduce the total heat requirements of a given house considerably below that of a similar home using a fuel-fired furnace. However, even if the foregoing results could be increased by 20 percent, it is apparent that strictly competitive operation would still require a price of electricity in the range of from 1¼ to 1½ cents per kwhr. On the other hand, the heat pump has so many important advantages, including summer cooling in par-

Table 2—Comparative Data Electrically-Driven Heat Pump
(Prices of Electricity Which Will Compete With Coal, Oil or Gas Under the Assumptions Indicated[a])

Condenser Temperature F	Evaporator Temperature F	Coefficient of Performance	Competitive Price of Electricity vs: Coal	Oil	Gas
110	10	2.97	0.80	1.02	1.02
	20	3.32	0.89	1.14	1.14
	30	3.77	1.02	1.29	1.29
	40	4.32	1.17	1.49	1.49
120	10	2.84	0.77	0.97	0.97
	20	3.16	0.85	1.08	1.08
	30	3.54	0.96	1.22	1.22
	40	4.05	1.09	1.39	1.39

[a]From a report by R. A. Budenholzer, Professor of Mechanical Engineering, Illinois Institute of Technology. Table is based upon coal, 14,800 Btu per lb at $11.69 per ton, 50 percent furnace efficiency; No. 3 Oil, 137,500 Btu per gal., 9 cents per gal., 65 percent furnace efficiency; gas, 7 cents per therm (100,000 Btu), 70 percent furnace efficiency. Prices are for the Chicago area as of early 1947 and coal and oil costs, in particular, would be materially higher as of February 1948. An overall motor-compressor efficiency of 60 percent is assumed.

ticular, plus the ultimate in cleanliness, safety and control, that it probably will not be necessary to sell this equipment solely on a cost-of-operation basis. Nevertheless, if a large market is to be obtained, competitive costs will be a factor and the differential should be kept at a minimum. In achieving this result, it is my opinion that the greatest single opportunity to reduce costs will be found in the use of units having the smallest possible capacity, but operating the greatest number of hours. If a heat pump can be designed and applied to meet this prerequisite, the author is confident that its place in the field of residential heating and cooling will be assured.

E. N. Kemler, New York, gave an abstract of the paper, **Research Aspects of the Heat Pump,** by E. N. Kemler and N. Kulik (published in this issue, April 1948, JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Chairman Avery next called upon Marvin Smith, Muncie, Ind., who was assigned the subject, Operating Data of the Heat Pump.

Mr. Smith stated that there were four questions from the manufacturers' viewpoint in connection with heat pumps: (1) Can it be engineered? (2) Can it be built? (3) Can it be sold? and (4) Will it stay sold? Since his experience began with two heat pump installations in 1944 the number of installations in homes had grown as follows: Seven in 1945, 25 in 1946, 202 in 1947. It was estimated that the total installations which had all been made below the Mason-Dixon line now numbered approximately 300.

G. Lorne Wiggs, Montreal, Que., Canada, at the request of the chairman, described an application in which a refrigerating system was required on two floors while panel heating was used on the third floor of a building. During the heating season the condensing water from the refrigeration compressors was used as the heating medium in the panel heating system. In summer when the heating system was not needed, an evaporative condenser was used. Mr. Wiggs stated that electricity was available in Canada at 2½ mills per kwhr. Water temperatures in rivers and wells were cool, however, and this constituted a disadvantage.

Chairman Avery declared the meeting open for questions and asked the authors on the rostrum to answer the questions written on the cards returned from the audience.

K. C. RICHMOND, Chicago, Ill., inquired about the electric rate in Portland, Ore., and also what it would cost to heat the same building in Chicago.

MR. KROEKER replied that the rate was 3.15 mills per kwhr with a demand charge of $1.00 per kw demand. He did not have information on Chicago power rates.

J. N. LIVERMORE, Detroit, Mich., asked what means were taken to prevent the tempering coils in the inlet air from freezing.

MR. KROEKER replied that the chilled water discharged from the cooling coils at about 50 F increased in temperature to 53 F in the coils in the ventilation exhaust air, and then cooled to 45 F in the coils in the ventilation supply air. The final temperature was therefore well above freezing.

MR. OLDENBERG, Springfield, Mass., suggested that it might be more economical to supply heat at peak periods by means of electric current.

MR. JOHNSON stated that this might be true in regard to first cost, but not in regard to cost of power over a long run because the power demand or load factor might be affected adversely, *i.e.*, the load factor might be decreased by using direct resistance heating. In some installations, however, direct heating is used, but its practicability depends entirely upon the application.

Replying to an unsigned question inquiring 'What was meant by building houses for future addition of summer cooling with heat pumps', Mr. Johnson stated his belief was that in 10 years, year-round air conditioning in the home will be a fairly common thing, and that probably the heat pump will be part of the equipment. He believed, therefore, that consideration should be given to the means for providing summer cooling and the design of ducts which should obviously be larger for summer air conditioning.

JOHN REYNOLDS, New York, N. Y., was asked to comment from the viewpoint of an architect. He remarked that the space required by equipment is very important and that manufacturers and designers should work together with architects in order that the house can be properly designed, and suitable arrangements made for the equipment.

In reply to an unsigned question 'Will the utility companies be prepared to handle the load of numerous residence heat pumps with present distribution systems', Mr. Herrman stated that due to the fact that no two distribution systems are the same, the question could not be answered yes or no. Some systems could handle the present potential load without change; others are being increased to keep abreast of the domestic load.

Answering a question, 'How many homes connected to your lines have heat pumps installed', Mr. Herrman estimated that only four residences were so equipped in the Commonwealth and Southern System.

MR. BORDEN, Evansville, Ind., asked about the source of heat in most U. S. heat pump installations.

MR. SMITH stated that about 75 percent of his installations employed a U-tube to extract heat from wells. In a few installations, heat was extracted from the ground and in such cases, success depended upon the heat transfer rate of the ground.

J. F. L. GROCOTT, London, England, suggested that it did not seem reasonable to use high grade heat such as obtained from electric power for domestic heating purpose. It seemed to him that the use of a heat pump with a coefficient of performance of 4 constituted only a limited improvement to assist the performance of a power source which should not be used for such low grade service. He inquired whether the heat pump for domestic use employing an electric prime mover would be a serious competitor of an

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efficient district heating system using steam or hot water.

MR. HERRMAN replied that an average electric distribution system had a thermal efficiency of about 25 percent (some systems exceed this value) and therefore a coefficient of performance of 4, the actual delivery of heat in a domestic installation, would equal the heat in the fuel used to generate the electricity. Mr. Herrman believed that the city of Norwich, England, had been installing a heat pump on the basis that it would conserve natural resources by reducing the amount of fuel taken from the earth in the form of coal.

In Switzerland, where coal is scarce, the use of electric power to extract heat from river water or lake water is considered to be efficient and also a means of saving natural resources.

E. R. AMBROSE, New York, N. Y., stated that Mr. Johnson, in his analysis of comparative fuel costs, had used a coefficient of performance of 3.5. He asked Mr. Johnson to comment on the possible improvement of this coefficient by means of improved equipment.

Mr. Johnson replied that the principal problem in increasing the coefficient of performance was that of obtaining a compressor and motor combination with which the capacity could be varied from 25 to 100 percent and still retain good performance at low capacities. Typically, a compressor would have 70 to 75 percent adiabatic efficiency at rated conditions. Operating the compressor at half capacity would drop the compressor efficiency 50 percent, but the motor efficiency would drop about 64 percent, so that the adiabatic efficiency, instead of being 70, would drop to about 55 percent. Since heat pumps operate at low capacities over extended periods, the average coefficients of performance for the season would tend to be unfavorable.

At present a heat pump installation taking heat from the air could be designed with a coefficient of performance of about 2.8, including all auxiliary power. The design cop is therefore 2.8. For a typical season having considerable periods of mild weather, the cop would probably increase to 3.5, and at certain times in the season it might exceed this value.

Studies were being made at present to determine the best means of obtaining the capacity modulation.

Chairman Avery then declared that questions could be presented from the floor.

Y. S. TOULOUKIAN, West Lafayette, Ind., referred to Mr. Herrman's use of 25 percent overall thermal efficiency for electric power distribution, and the coefficient of performance of 4 which yielded 100 percent utilization of the energy of the fuel. He pointed out that unless the owner of the heat pump also owned the power plant, he would not obtain the advantage of utilizing 100 percent of the energy of the fuel. He also suggested that promises should not be made to the public far in advance of ability to supply any type of equipment. Due to the publicity that had been given the subject of the heat pump in the various papers and publications, the public is encouraged to believe that it is a wonderful device already available, while practically no information can be given regarding its availability for general use. Mr. Touloukian suggested that the heat pump be refined in industrial and commercial fields before it is made available to the average citizen for domestic use.

H. M. SMITH, Tampa, Fla., cited his experience in selling and installing about 23 air-to-air units of various sizes in Florida where the electric power rate is 2 cents per kwhr. Monthly bills on 5-ton units were found to be about $25.00 to $30.00. Experience in operating the installations mentioned had shown that during the day, when the sun was shining and with the unit operating on the refrigeration cycle, indoor conditions were perfectly comfortable, but late in the afternoon and during the night when the temperature was in the middle 70's, and the refrigeration section of the unit was not in operation, the humidity within the house became exactly the same as that outside due to the introduction of ventilation air by the circulating fan.

WILLIAM M. WALLACE, II, Durham, N. C., stated that no mention had been made regarding the flow within the wells, and since in certain territories such as the middle part of North Carolina, the flow of water through the ground is low, it would be insufficient to carry off the cooling effect.

MARVIN SMITH, replying to Mr. Wallace, stated that the basis of design which he had used was a minimum movement of water of 4 miles per year. A greater flow would, of course, be advantageous.

G. B. PRIESTER, Baltimore, Md., referred to W. E. Johnson's paper as one of the best on the widely publicized subject of the heat pump. He believed that the paper would assist the engineer in forming a sound judgment and prevent some of the unwarranted enthusiasm that has been shown in many magazine articles.

In making an investigation of the possibility of using earth as a supply of heat, Mr. Priester had made a number of calculations based on reasonable assumptions and not on steady state conditions. These calculations indicated that when the heat abstracted from the earth was obtained only from the original storage in the earth, and when this transfer of heat to the cooling surface was obtained by conduction only, the total surface required would be too large to be driven into the earth. The calculations covered an initial 20-year period of operation.

If the relatively small amount of heat normally to be removed from a house by summer cooling would be returned to the earth, the amount of surface required would be reduced only slightly. If the quantity of heat returned to the ground in summer should deliberately be made equal to that removed in winter, the earth would then be used essentially as a heat storage reservoir rather than a heat source. In this case, if the contacting surface is a cylinder the surface required would not be reduced a great deal. If the heat transfer surface consists of a horizontal coil network that would act effectively as a plate, the amount of surface required would be substantially less than when no heat is returned to the earth. Nevertheless, the surface, even for periodic storage purposes for use with a very small, well-insulated house, would appear to be over 4000 sq ft or greater than an area 80 x 60 ft.

Mr. Priester referred to a recommendation of one heat pump manufacturer that from 500 to 700 ft of tubing be used with a 3 hp unit. This manufacturer also recommended that the tubing be fabricated into a horizontal coil network that would cover an area of from 3200 to 4500 or more square feet. The installation of this amount of surface would represent an appreciable item in the initial cost of a heat pump system, and is one of the important and currently objectionable economic factors previously mentioned by Mr. Johnson.

Special circumstances, such as a substantial movement of ground water reasonably close to the heat transfer surface, would alter the amount of surface required. Coils buried near the earth's surface would draw heat from the atmosphere if operated on a sufficiently low temperature, but in such a case stored heat in the earth would not be the actual heat source. It was Mr. Priester's opinion, however, that engineers would find a solution for many of these problems.

I. B. FIELDHOUSE, Chicago, Ill., referred to work at the Armour Research Foundation dealing with method of calculating the effect of freezing of moisture in the soil on the temperature of pipe surface buried in the ground as a function of time for a constant rate of heat withdrawal from the earth using the soil as a source of heat for a heat pump.

Assuming a withdrawal of heat at a constant rate of 30 Btu per (hr) (linear ft of 3 in. pipe) and assuming that the earth is initially at 50 F, it was found that after 3000 hours of continuous operation the evaporator temperature would be 27 F and the radius of frozen soil 2¼ ft. It was therefore concluded that this withdrawal of heat would not result in excessively low surface temperature and that a coefficient of per-

formance of 3 could be expected. These computations and some experimental work conducted at the Foundation lead to the conclusion that the earth as a source of heat is possible for domestic use without requiring an excessively large amount of ground.

As there were no further questions or comments, Chairman Avery suggested that the authors who had taken part in the presentation be given a rising vote of thanks.

The meeting was adjourned at 4:15 P.M.

Climatological Data for Selecting Design Temperatures

Sixth Session—Thursday, February 5, 10:00 a.m.

The concluding technical session of the Meeting was opened in the West Ballroom on Thursday morning at 10:00 a.m., with President Woods presiding. He announced the first paper, **A New Method for Selecting Winter Design Temperatures,** by C. M. Humphreys, Cleveland, Ohio, (published in the January 1948 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Mr. Humphreys gave a synopsis of his paper and at the conclusion of his presentation discussion was invited.

S. P. GOETHE, Tampa, Fla., stated that in 1931 the University of Tampa had a project which resembled the one described and he said that it was interesting to note that the values obtained, which would not be exceeded on over 97½ percent of the days, is a few degrees lower than recommended by the author. He thought that rather than advocate a change in design temperatures, that more data on periodic heat transfer of building construction should be obtained.

W. L. FLEISHER, New York, N. Y., stated that his investigations in the heating art started with the determination of design temperatures, and he felt that the problem that had never been settled was the effect of wind on the design temperature. He also said that the problem had been discussed for over 35 years in the Society and a good many field tests were run to determine the effects on basic design temperatures. He pointed out that in New York where we do not get as low temperatures as in other sections of the country we do have an average wind velocity in the winter which is higher than in many other places, and he felt that the matter should receive continued investigation. He thought that the paper was incomplete in this phase of the work.

J. W. MILLER, Lansing, Mich., referred to some research that had been carried on to determine what recommendation should be made on design temperatures. He indicated that the lowest temperatures generally occur during the night when thermostats are shut down. Experience has indicated that if the code recommendations are followed our furnaces have always been too large.

G. LORNE WIGGS, Montreal, Canada, suggested that the author might consult several papers covering weather in Canada and recommended that before the paper appears in the Society's TRANSACTIONS that data from two or three Canadian cities be added. He felt that some slight error in the design basis might not be troublesome with a steam, hot water or warm air system, but a radiant heating system with floor panels would experience difficulty.

C. E. FERGUSON, Salt Lake City, Utah, pointed out that research carried on in Army installations indicated that the amount of available sunshine in a locality affected design temperatures, particularly on the Pacific Coast.

CYRIL TASKER, Cleveland, Ohio, thought that several of the discussions referred to design conditions, while his impression of the paper was that it deals with design temperatures and careful reading of the paper would indicate that the author has suggested nothing that would eliminate the judgment of the designing engineer.

MR. FLEISHER agreed that the paper gave a description of methods of selecting the lowest temperatures, that prevail at any time, from our meteorological data. He stressed the fact that we do not know how to design our heating systems because we have not followed through to a conclusion. He stated that he did not believe that it is any more important to know what the lowest temperature is, than to know what the prevailing wind is at that particular temperature. To improve present practice, Mr. Fleisher felt that it is important for the Society to give this matter consideration.

MR. HUMPHREYS stated that the diurnal variations in temperature must be considered as a factor for permitting a higher design temperature than we have been using. Work done primarily for summer cooling has given us some clue to the magnitude of lag that may occur in various constructions. Wind velocity is important, but was not included in the paper because it might well be a matter of a separate investigation. The data for this paper were taken between 1936 and 1938 by W.P.A. workers for the U. S. Weather Bureau and unfortunately did not include Canadian weather data. The matter of sunshine cannot be considered very accurately, but it offers a factor of safety to the heating engineer.

President Woods introduced H. E. Landsberg, Washington, D. C., formerly head of the Climatological Section of the Weather Bureau, whose subject was **Use of Climatological Data in Heating and Cooling Design** (published in the October 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

JOHN EVERETTS, JR., San Francisco, Calif., said that the two authors had indicated quite a difference of opinion as to the normal or mean temperature. Mr. Humphreys seems to feel that the daily mean is a better indication of heating load, and a mean temperature is a better indication for heating design. Mr. Landsberg has pointed out that they are of no particular value and the work of J. C. Albright indicated that normals or means are of little or no value. Mr. Landsberg refers to seasonal value in degree days of cooling and the deviation from the logarithmic normal. The value to the design engineer is questionable because no account has been taken of the wet bulb temperature in determining the degree of cooling load. It is suggested that data be obtained on the effect of cumulative frequencies of wet bulb for cooling degree value.

Mr. Everetts was in agreement with the statement that weather data are only good for the immediate location of the station for which the data are taken.

A. A. GIANNINI, New York, N. Y., stated that there could be great differences in the design temperatures in points within one city, and in New York data taken simultaneously at the Battery station is entirely different from that obtained at the Central Park station, or at La Guardia Airport, or at Newark Airport.

He thought the matter deserved greater attention than it has had in the past.

MR. LANDSBERG said that he is aware that for summer cooling problems the wet bulb temperature is more advantageous and he fully agrees with Mr. Everetts on this point. He explained that evaporation is one of the most elusive meteorological factors and if the question were asked, how much evaporative cooling can be expected in a certain locality this type of data could not be given as of the moment.

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Installation of Officers

President Woods announced that the installation of officers would be conducted by W. H. Driscoll, past president of the Society.

Mr. Driscoll said that in addition to the president, first and second vice presidents and treasurer, the Council consisted of 12 members, four of whom are elected annually to serve for three years, and the retiring past president of the Society and chairman of the Committee on Research serve on the Council. To the retiring members of the Council he expressed, on behalf of the Society, the sincere appreciation for the personal sacrifices that they made and the valuable contributions that they made toward the Society's progress. He then called the newly elected Council members, D. M. Allen, Kansas City, F. A. Hamlet, Montreal, Que., Canada, C. S. Leopold, Philadelphia, Pa., and H. E. Sproull, Cincinnati, Ohio, to the rostrum.

He welcomed Dean L. E. Seeley, Durham, N. H., newly elected treasurer and then called for L. T. Avery, Cleveland, Ohio, second vice president, and A. E. Stacey, Jr., Syracuse, N. Y., first vice president.

Prof. G. L. Tuve, president-elect was presented and Mr. Driscoll said, "you have now achieved the highest honor in the Society and in welcoming you to the high office of president we believe that the steady progress of the Society will continue. You are now taking your place as the 54th president of the Society and I know that you will maintain the high standards that have been set up by the long line of distinguished predecessors."

President Tuve then took the gavel and expressed his appreciation for the honor of being president of the Society and said that he felt that one of the greatest compensations the Society offers is the strong friendships that are formed during the years of service in Society work. He announced the total registration as: Members—1009; Guests—490; Ladies—306; Total—1805.

John Everetts, Jr., secretary of the Chapter Delegates Committee, presented a resolution which was offered by the Chapter Delegates Committee in accordance with Article C-XVI, *Section 1*, of the Society's Constitution and By-Laws, as follows:

RESOLVED that in the interest of best serving the membership of the Society as represented by the Chapter Delegates Committee that the chairman of the Chapter Delegates Committee be included as an ex-officio member of the Council for ready presentation of views of this committee on matters of policy affecting the local chapter organizations' activities,

AND to this end that the Constitution of the Society be amended accordingly by the addition of the following wording to Article C-V, *Section 1* of the Constitution: After the words "Committee on Research," insert "and the Chairman of the Chapter Delegates Committee."

On motion, properly seconded, it was voted,

THAT the amendment be approved and referred to the Constitution and By-Laws Committee for final drafting and submission to the membership.

The motion was unanimously carried.

D. M. Mills, Houston, Tex., chairman of the Resolutions Committee then presented his report as follows:

Resolutions

WHEREAS, Dr. Baldwin M. Woods has served on many Society Committees as member and chairman, has served on the Council since 1942 to the present time, was First Vice President in 1946-47, and has been President in the year just ended,

WHEREAS, his continuous and able application to Society duties has been outstanding and has contributed to maintaining the high standards set by previous officers,

BE IT RESOLVED, That the ASHVE extends its grateful thanks and appreciation to him for his aggressive and yet unselfish activity in behalf of the Society.

WHEREAS, the 54th Annual Meeting of the Society here at New York has been an exceptional success through the efforts of the New York Chapter, presided over by its President, M. C. Giannini, and through its Committee on Arrangements under the able leadership of Walter E. Heibel, and

The assistance of all other organizations and individuals who assisted in providing opportunities for instruction and entertainment therefore,

BE IT RESOLVED, That an expression of appreciation be adopted and that copies be sent to each of the following:

To M. C. Giannini, president of New York Chapter.

To Walter E. Heibel, chairman of Committee on Arrangements and to his several committee chairmen, members, and their ladies.

To Randolph H. Carpenter, toastmaster of the Banquet.

To the authors of technical papers.

To the New York Convention and Visitors Bureau for its cooperation and assistance in registration and housing.

To Charles F. Roth and his staff for the splendid 8th International Heating and Ventilating Exposition held concurrently with our Meeting.

To William E. Haskell for his inspiring talk at the Welcome Luncheon.

To William B. Stout for his entertaining address at the Annual Banquet.

To members and guests of Society attending from the following eight countries: Czechoslovakia, England, France, India, Mexico, Norway, Sweden, and Switzerland.

To the New York Hotels for their splendid cooperation and to the Hotel Commodore for an excellent banquet and courteous service.

To the Newspapers and Trade Papers for their coverage of this Annual Meeting.

To the American, United and Trans-Canada Airlines for their assistance in transportation.

To the Languild Service for its courteous service to members.

Respectfully submitted,
D. M. Mills, *Chairman*
S. L. GREGG
H. D. BRATT

On motion, properly seconded, the resolutions were unanimously adopted by standing vote.

The 54th Annual Meeting of the Society adjourned at 11:30 a.m. on Thursday, February 5, 1948.

Semi-Annual Meeting at Bretton Woods

The Council has announced the dates of the Semi-Annual Meeting 1948 as June 21-23 and the Mount Washington Hotel, Bretton Woods, N. H., has been selected for the meeting.

This location, in the heart of the White Mountains, will make an attractive summer meeting place and the Program and Papers Committee has announced three technical sessions.

The Council has accepted the cooperation offered by the Massachusetts Chapter which will act as host for the occasion. President Ehrenzeller has announced the appointment of Carl M. F. Peterson as general chairman of the Committee on Arrangements.

Detailed program arrangements will be announced to the members shortly and hotel reservation cards will be mailed to all members in ample time.

Summary of Local Chapter Meetings*

ATLANTA—February 12, 1948. Subject: Air Conditioning of Buses. Speakers: Randolph Whitfield and W. V. Neisus, Georgia Power Co. Mr. Whitfield, assisted by Mr. Neisus, gave a very instructive and interesting talk, and a lively discussion period followed. Other Features: Reports were given by committee chairmen, and Pres. L. L. Barnes gave a brief account of activities at the 54th Annual Meeting. A motion was carried that the plans of the American National Red Cross for an Atlanta Blood Center be endorsed. Attendance 33. Attendance ratio 0.22.

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GOLDEN GATE—February 5, 1948. Subject: Radiant Heating by Low Voltage Electric Currents. Speaker: Ruben S. Tice. Mr. Tice explained how electric panel heating was developed as a heating method when the cost of electricity dropped from its original high level. A description was then given of the radiant heating system developed by Mr. Tice, which uses a current transformer with bare stranded cable imbedded in the floor, with voltages of 20 to 70, and a current consumption of 10 to 15 watts per square foot of heated area. Also necessary in his system, explained Mr. Tice, is an extremely sensitive thermostat; and good insulation is necessary in any home electrically heated. Mr. Robeson, the first to investigate the radiant heating method in this country, was also present at the meeting. He spoke briefly on his experiences in the Pacific Northwest, where he developed his system. Members found the talks of both Mr. Tice and Mr. Robeson highly informative and many questions were asked of both speakers. Attendance 69.

GOLDEN GATE—January 8, 1948. Subject: Acoustic Problems in Air Conditioning. Speaker: Robert B. Tellfer, manager, acoustic division, Western Asbestos Co., San Francisco, Calif. Other Features: The chairman of the program committee reported progress made by his group. Attendance 66.

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ILLINOIS—February 9, 1948. Subject: Role of the *Water Doctor* in Heating and Ventilating. Speaker: Leo F. Collins, consulting engineer, Detroit, Mich. Mr. Collins pointed out that while many other industries had accepted the need for *water doctoring*, the heating and ventilating industry has not yet recognized the necessity for this phase of engineering. The effect of scale and corrosion on boilers and other types of heat exchangers and the various methods of controlling scale corrosion were explained by Mr. Collins. This interesting presentation was illustrated with slides. Other Features: Reports on the activities of the various chapters were given. W. A. Kuechenberg, chapter president, gave his report as delegate to the 54th Annual Meeting. Attendance 74. Attendance ratio 0.219.

ILLINOIS—January 12, 1948. Subject: Vibration Control of Air Conditioning Equipment. Speaker: Mr. Rosenzweig. Vibration control, as explained by Mr. Rosenzweig, was considered a luxury 20 years ago, but is now considered a necessity. Scientific vibration control engineering has resulted in increased output of machines, and reduction in initial and maintenance costs. This interesting presentation concluded with Mr. Rosenzweig's discussion of slides showing the various types of mounting plates. Pres. W. A. Kuechenberg commented on the 54th Annual Meeting, and stated that the next annual meeting would be held in Chicago. Attendance 103. Attendance ratio 0.277.

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IOWA—February 10, 1948. Subject: Current Practice in Automatic Temperature Control for Heating and Air Conditioning. Speaker: J. R. Vernon, sales promotion manager, Johnson Service Co., Milwaukee, Wis. With the aid of slides, Mr. Vernon explained current practices and fundamental principles in the use of control for heating, ventilating and air conditioning. Mr. Vernon's interesting presentation also included information covering control of reverse cycle refrigeration systems and the possibilities of various electronic circuits. Other Features: John Sandfort, Iowa State College, invited members of the Society to attend the Midwest Power Conference to be held in Chicago on April 7, 8 and 9. A committee was appointed to assist Marvin Gould in planning the Air Conditioning Conference to be held at Iowa State College March 22 to 25. Attendance 36.

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MASSACHUSETTS—January 28, 1948. Subject: Technology Tomorrow. Speaker: Dr. B. M. Woods, president of ASHVE, and director, university extension, University of California, Berkeley, Calif. Before presenting his major topic, Dr. Woods reviewed the basic tenets and purposes of the Society and told why he had selected the ASHVE as his engineering Society. In his main talk on technological advances, Dr. Woods reviewed the far reaching changes in our everyday life caused by past inventions and pointed out possible future developments and the changes they will bring about. Many interesting questions were asked Dr. Woods following his informative address. Attendance 40. Attendance ratio 0.48.

*Note: The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

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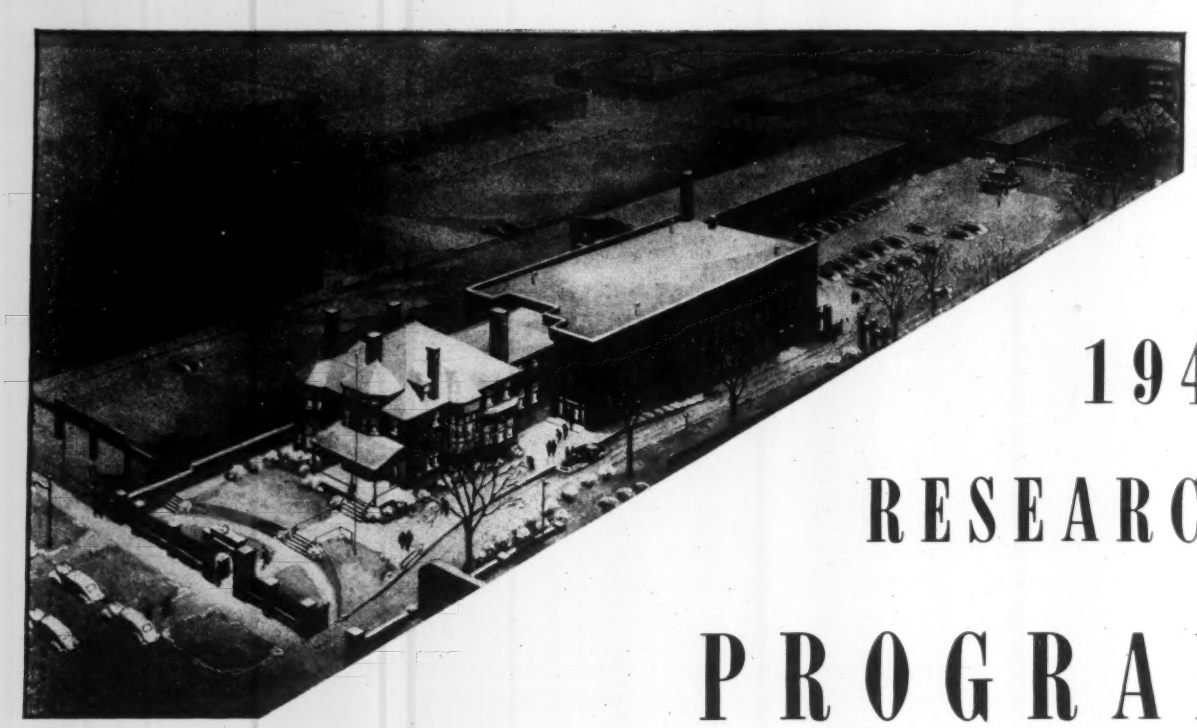

1948 RESEARCH PROGRAM

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Air Cleaning

The development of standard procedures for the rating and testing of air cleaning devices.

Air Distribution

A study of the fundamentals of the behavior of ventilation jets (partially in cooperation with Case Institute of Technology)

The discharge of air in free and confined spaces (in cooperation with Case Institute of Technology)

The investigation of stream patterns of heated air projected vertically downward. (in cooperation with Kansas State College)

Air Flow Friction

The study of friction losses in through-flow fittings used in ventilation work.

Combustion Equipment

Studies on the characteristics and performance of barometric draft controls.

The study of methods to differentiate between the burning characteristics of fuel oils. (In cooperation with the Oil-Heat Institute of America, Inc.)

Fluid Flow

The effect of secondary turbulence on the friction in a flowing stream of water. (In cooperation with Agricultural and Mechanical College of Texas)

Heat Transfer

(a) Forced convection and natural convection heat transfer from smooth and ribbed surfaces—a study of film coefficients.

(b) Heat transfer coefficients of evaporating refrigerants (in cooperation with Case Institute of Technology)

(c) Cooling tower design and performance (in cooperation with University of California)

(d) Investigation of radiation exchange between an enclosed space and the atmosphere as affected by glazing of various types. Studies include direct transmission of radiant energy, absorption and re-radiation of radiant energy and conductance and dissipation of sensible heat by convection.

(e) Development of design tables for periodic heat flow, including solar radiation transmission.

Panel Heating and Cooling

The study of the heat distribution within and behind typical panels as affected by the type, size and spacing of the conductors, the properties of the panel materials, the temperature of the heating medium and the insulation above, below and at the edges of the panels.

Determination of thresholds of comfort and their correlation with mean radiant temperature. (In cooperation with Kansas State College)

The emissivity of heated and unheated surfaces as a factor in the design of panel heating systems. (In cooperation with Kansas State College)

Physiological Research

The physiological effects of sudden changes of environment on healthy and physically impaired adults of both sexes. (In cooperation with the Department of Medicine, University of Illinois)

PROJECTS UNDER STUDY AND DEVELOPMENT BY TECHNICAL ADVISORY COMMITTEES

Air Sterilization

The development of codes of practice for sanitary control of epidemic air-borne contagion by ventilation.

Corrosion

The study of water-formed deposits and corrosion in heating and air conditioning equipment.

Heating Load

The analysis of the various factors comprising the heating load and the development of additional and more accurate data on infiltration, basement heat losses and weather design values.

Industrial Ventilation

The development of reliable and practical information for ventilating engineers on the control of industrial atmospheres.

Insulation

The correlation of values for the thermal conductivity of building material by hot plate tests. (In cooperation with 20 other laboratories.)

Sorbents

The characteristics of dessicants and their application for industrial, commercial and residential use. The development of a preliminary code for rating dehumidification equipment.

Sound Control

Determination of methods for acoustical testing of ventilating fans and systems and of predicting the acoustical performance of ventilating systems. (In cooperation with Material Laboratory, U. S. Naval Shipyard, N. Y.)

Weather Design Conditions

The preparation of statistically sound weather design data for winter and summer. The development of sol-air temperature data for use in periodic heat flow calculations.

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Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When the replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 128 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by April 20, 1948, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

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North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, E. S. deWitt, 1211 Commercial Bank Bldg., Charlotte. Secretary, R. M. Warren, Jr., 1001 N. Church St., Charlotte 1.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, B. S. Foss, Jr., 711 Construction Bldg., Dallas 1. Secretary, Herman Blum, Jr., 2812 Fairmount St., Dallas 4.

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South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, D. M. Mills, Gray and Crawford, Houston 3. Secretary, L. L. Ladewig, Box 1188, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Third Wednesday. President, R. A. Lowe, 6381 Hollywood Blvd., Los Angeles 28. Secretary, John L. Blake, 1700 S. Bedford St., Los Angeles 35.

Southwest Texas: Organized, 1946. Headquarters, San Antonio, Tex. President, F. C. Benham, Jr., 702 S. Flores St., San Antonio. Secretary, L. S. Pawkett, 810 Insurance Bldg., San Antonio 5.

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Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, E. V. Gritton, 2470 S. 15th, Salt Lake City 5. Secretary, C. E. Ferguson, 838 Garfield Ave., Salt Lake City.

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Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, H. H. Hill, 438 Woodward Bldg., Washington 5. Secretary, J. G. Muirheid, 2013 New Hampshire Ave., N. W., Washington 9.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, Frank Harbin, Jr., 280 E. 6th St., Holland. Secretary, W. C. DeRoo, 500 E. 8th St., Holland.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, G. E. Adema, 39 W. Balcom St., Buffalo 9. Secretary, J. H. Bryce, 88 E. Girard Blvd., Kenmore.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, J. R. Vernon, 507 E. Michigan St., Milwaukee 2. Secretary, B. M. Kluge, 1817 S. 66th St., Milwaukee 14.

Student Branch

Texas A. & M. College: Organized, 1946. Headquarters, College Station, Tex. Meets, Third Thursday. President, S. E. Ammons, 212 13th Ave., No., Texas City. Secretary, C. P. Howard, Box 1706, College Station.

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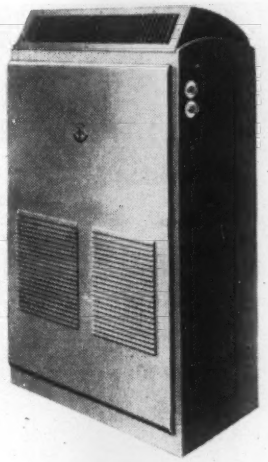
For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1948 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Split Pan Condensate Removal System Used in Conditioner



No. 3721—Development of a new 1½, 2, and 3 ton packaged air conditioner has been announced by Typhoon Air Conditioning Co., Inc., 794 Union St., Brooklyn 15, N. Y. Taking its place alongside the company's larger units which are made in 3, 5, and 7 ton sizes, the new console units are now being distributed.

Featuring several refinements in design, it has a new split pan condensate removal system that is said to serve a double purpose by creating an even flow of air through the cooling coil, thereby insuring maximum heat transfer over its entire area. The condensers are all-copper with exterior return bends. Flexible copper tubing is used to make the water connections, and the large, slow speed compressor is designed to give high output per horsepower with low noise level.

Photoelectric Cell Used To Control Combustion

No. 3722—Type SA "Robot-Eye" is an electronic oil burner combustion control developed by General Power Plant Corp., 381 Fourth Ave., New York 16, N. Y., for use in apartments, hotels, office buildings, and industrial plants. According to the manufacturer, it is a simple, inexpensive, and practical device for maintaining CO_2 at a uniformly high value without smoke formation. It is designed and built particularly for the control of rotary cup type oil burners and may be used with steam or pressure atomizing burners using No. 5 or No. 6 fuel oil.

In the device, "haze density" present in the breeching causes variations in the current generated by a photoelectric cell. The current is indicated on a microammeter in the control panel. Through appropriate translation equipment the position of the microammeter needle determines the direction, magnitude, and speed of movement of a reversible motor controlling admission of air to the furnace. In this way, says the manufacturer, the correct fuel air ratio to promote proper "haze density" for most efficient operation is maintained.

Halogen Compound Detector Used for Refrigerant and Other Leaks

No. 3723*—A new portable leak detector especially designed for production testing of hermetically sealed refrigeration units in which halogen compounds are the refrigerants has been announced by General Electric Co., Schenectady 5, N. Y. Other applications of this instrument include locating leaks in tanks, boilers, piping, and other closed systems into which halogen compounds can be introduced as a tracer.

The new instrument, says the company, can detect a leak so small that it will release only 0.01 oz of "Freon" in one year. It is designed to inspect, in a few seconds, an ordinary joint or seam for leaks and, in addition, is suitable for service testing in the field as well as for assembly line use. The detector unit weighs 3 lb and the control unit 15 lb.

The detector unit is a hand held probe with a pistol grip, having a metal nozzle with a plastic tip. The unit contains a sensitive element, responsive to halogens in the air, and a motor driven blower which circulates the air through the sensitive element. An 8 ft cable lead is supplied to connect the detector unit to the control unit.

The control unit is a self contained, portable unit containing the power supply, amplifier, indicating instrument, necessary controls, and a carrying strap. A 25 ft lead is supplied for connecting the control unit to a 115 volt, 60 cycle power supply.

The nozzle of the probe is held about ½ in. from the surface being tested. As the nozzle passes over a leak,

[*Continued on page 188*]

Heating, Piping & Air Conditioning **[4-48]**
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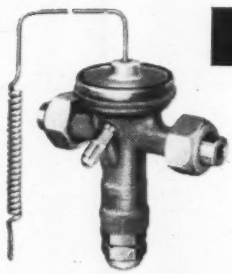
Desire for comfort has been one of the great driving forces of civilization. As soon as man assures himself enough to eat, he sets about improving his comfort. He is willing to spend plenty of money to do it. That desire for comfort can make profit for you and for the users of air conditioning.

Soon people will be flocking to air conditioned stores, movies, taverns, etc. Those who can afford it will be thinking about air conditioning for homes and offices.

Start now to sell air conditioning, and remember "Detroit" Thermostatic Expansion Valves provide the most satisfactory, trouble-free refrigerant control.

Available in the desired capacities, they have the dependability and durability to give long service without attention.

"Detroit" Thermostatic Expansion Valves are gas-charged—which gives them close regulation—guards against motor overload. Often, gas charging makes possible use of a smaller motor, since it does not have to work against excessive pressure during the pulldown period. Gas-charged valves balance the system more quickly when starting up, insuring fast, positive action.



"DETROIT" No. 899

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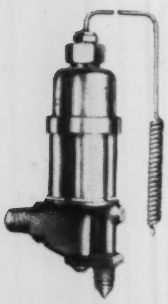
An air conditioning or commercial valve of intermediate capacity. Incorporates the features of single diaphragm construction and gas charging. Forged union connections are compact and make removal easy. Capacity 1.5 to 6 tons Freon-12.



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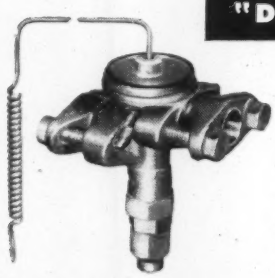
For many years, the standard of the air conditioning and refrigeration industry. Reliability proved by long service. Orifice sizes 3/64" to 7/32" with capacities up to 3½ tons Freon-12 and 6 tons Methyl.



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Representative of the "Detroit" large capacity line. No. 786 is rated 3 to 6 tons . . . No. 787—6 to 11 tons . . . No. 788—12 to 20 tons Freon-12. These valves have external equalizer connection and can be furnished with No. 790 distributor with 2 to 18 outlets for multiple distribution.

2989

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"DETROIT"

General Offices: 5900 TRUMBULL AVENUE, DETROIT 8, MICHIGAN

Division of American Radiator & Standard Sanitary Corporation

Canadian Representatives — RAILWAY AND ENGINEERING SPECIALTIES LIMITED, MONTREAL, TORONTO, WINNIPEG

"Detroit" Heating and Refrigeration Controls • Engine Safety Controls • Float Valves and Oil Burner Accessories • "Detroit" Expansion Valves and Refrigeration Accessories • Stationary and Locomotive Lubricators

To Help You Sell More—

Curtis AIR CONDITIONERS Are Advertised in the "SATURDAY EVENING POST" "TIME"

AND OTHER LEADING MAGAZINES

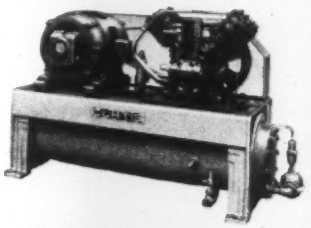
Starting April 24, Curtis Air Conditioners will be featured in full pages in color in the Saturday Evening Post and Time presenting the advantages of Curtis "Comfort Zone" Air Conditioning to more than 5,500,000 readers.

Here's your opportunity to reap the benefit of the great selling and merchandising power of these outstanding publications—reaching your major markets.

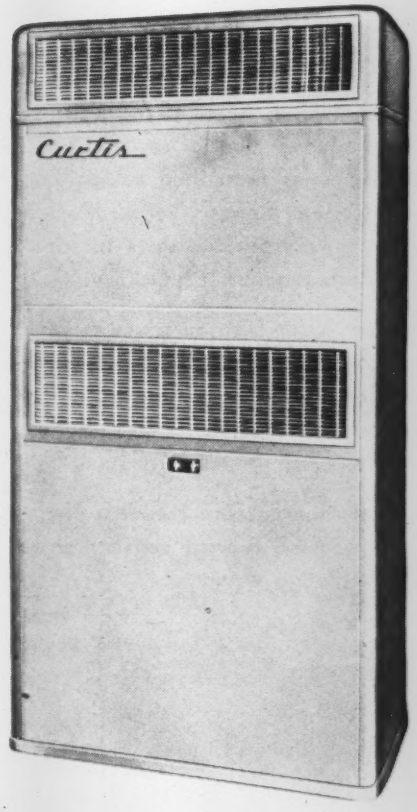
Sound design and engineering have proven Curtis units to be ideal for stores, offices, taverns, drug stores, apparel shops, beauty parlors, restaurants and many others.

It will pay you to get set to sell this vast and rapidly growing market *now*.

Write to Curtis for full information on how *you* can tie in with Curtis' new national advertising plans and assure more air conditioning sales and profits for 1948.



Curtis Condensing Units for Commercial Refrigeration—¼ to 30 H. P., air and water cooled.



Curtis Air Conditioning Units 3, 5, 7½, 10 and 15 Tons.

Curtis

REFRIGERATING MACHINE DIVISION

of Curtis Manufacturing Company

1950 Kienlen Avenue • St. Louis 20, Mo.

AB-597

94 Years of Precision Manufacturing

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FOR

Quality Products
Prompt Service
Profitable Cooperation

J. H. Mott, President, Mott Bros. Company

Buy from a Herman Nelson Distributor like Mott Bros. Company of Rockford, Illinois.

THE partnership between Herman Nelson and its carefully selected Distributors like Mott Bros. Company assures you prompt delivery of quality products as well as profitable merchandising cooperation.

Herman Nelson heating and ventilating products have produced superior results since 1906. Literature and sales promotion campaigns provided by The Herman Nelson Corporation have brought about many profitable sales for dealers and contractors throughout the country.

Herman Nelson Distributors meet your requirements promptly from stock for both equipment and installation materials. Members of the sales and engineering departments are available for immediate service.

Contact the nearest Herman Nelson Distributor when you need prompt delivery of quality heating and ventilating equipment.

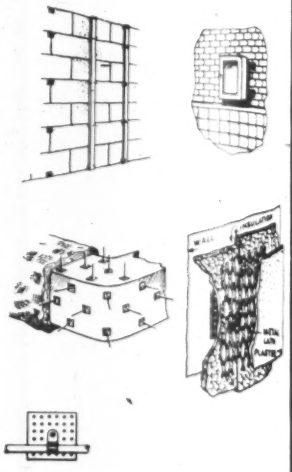
Herman Nelson Vertical Shaft Propeller-Fan Type Unit Heaters
Part of Herman Nelson's
QUALITY LINE
of Heating and Ventilating Equipment
Herman Nelson Horizontal Shaft Propeller-Fan Type Unit Heaters

THE HERMAN NELSON CORPORATION
Since 1906 Manufacturers of Quality Heating and Ventilating Products
MOLINE, ILLINOIS

[Continued from page 181]

halogen vapor is drawn in, and as this vapor reaches the sensitive element, an increase in current is indicated on the milliammeter. Provision is made on the control unit for using earphones or a loudspeaker to indicate leaks, in which case the indication will be an audible note with the pitch depending upon the size of the leak.

Metal Anchors Hold Insulation, Cables, and Small Pipes



No. 3724**—A "Miracle" surface anchor consists of a small perforated metal plate 2 in. x 2 in. or 2¾ x 2¾ in. to the center of which is welded a nail, spindle, bolt, threaded stud, or flat metal fins. The manufacturer, Devices, Inc., 280 Madison Ave., New York City, states that the anchors, bonded with the company's adhesive, are available for many applications.

When fitted with anchor nails, the device is used for attaching furring strips and plaster grounds, or for fastening partition sills to concrete floors, etc. Anchor bolts are generally used for attaching wall cabinets, fixtures, brackets, and similar equipment, whereas the spindle anchors are used primarily for attaching batt and blanket type insulation, particularly on metal surfaces such as large sheet metal ducts. Pronged anchors are recommended for supporting metal lath and block type insulation. Anchor supports and pipe straps are also fitted to the anchor plates by the manufacturer for use in supporting light cables, small pipes, air lines, etc.

The perforated base is designed to provide adequate anchorage by bonding with the company's adhesive to masonry, wall boards, plaster, tile, glass, etc. According to the company, no additional anchorage is required.

Evaporative Condenser Offered for Either Indoor or Outdoor Use

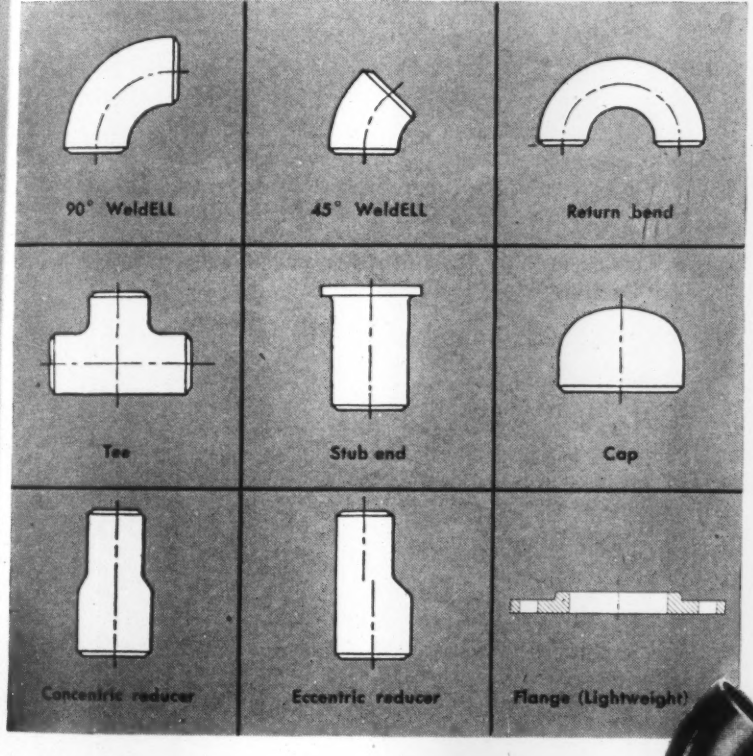
No. 3725—The model U evaporative condenser, for use with "Freon" and ammonia, is available in 19 sizes from 10 to 100 tons and is offered for either indoor or outdoor use by Baltimore Aircoil Co., 715-17 W. Pratt St., Baltimore 1, Md.

According to the manufacturer, the unit has been designed to facilitate installation and maintenance without sacrificing efficiency, quality, or size. A 45 deg air discharge elbow is used to direct the discharge either vertically or horizontally. On sizes under 50 tons the air intake may be taken either at the back or front of the unit.

Name the problem—

- *High temperature*
- *Low temperature*
- *Product purity*
- *Corrosion resistance*

Here's the answer!



Taylor Forge Welding Fittings and Flanges are available in:

Stainless 304, 316, 347, Monel, Inconel, Nickel, Copper . . . also other usual industrial metals.

Fitting sizes: ¾" through 12" and larger. Wall thicknesses: schedules 40-S, 80-S, 10-S and others. Flange sizes: ¾" through 30" and larger. Coupon brings dimensional data.

TAYLOR FORGE
& PIPE WORKS

General Offices: Chicago 90, Ill. (P.O. Box 485)
EASTERN PLANT: CARNEGIE, PA.

DISTRICT OFFICES

New York: 50 Church St. Philadelphia: Broad St. Station Bldg.
Chicago District Sales: 208 S. LaSalle St.
Houston: City National Bank Bldg.
Los Angeles: Subway Terminal Bldg.

☐ Send Taylor Forge Bulletin 476 covering stainless steel welding fittings and flanges.

☐ Add my name to your general mailing list.

Name_____

Position_____

Company_____

Department_____

Street Address_____

City_____ Zone____ State_____

510-0448

Mail to Taylor Forge & Pipe Works
P. O. Box 485, Chicago 90, Ill.

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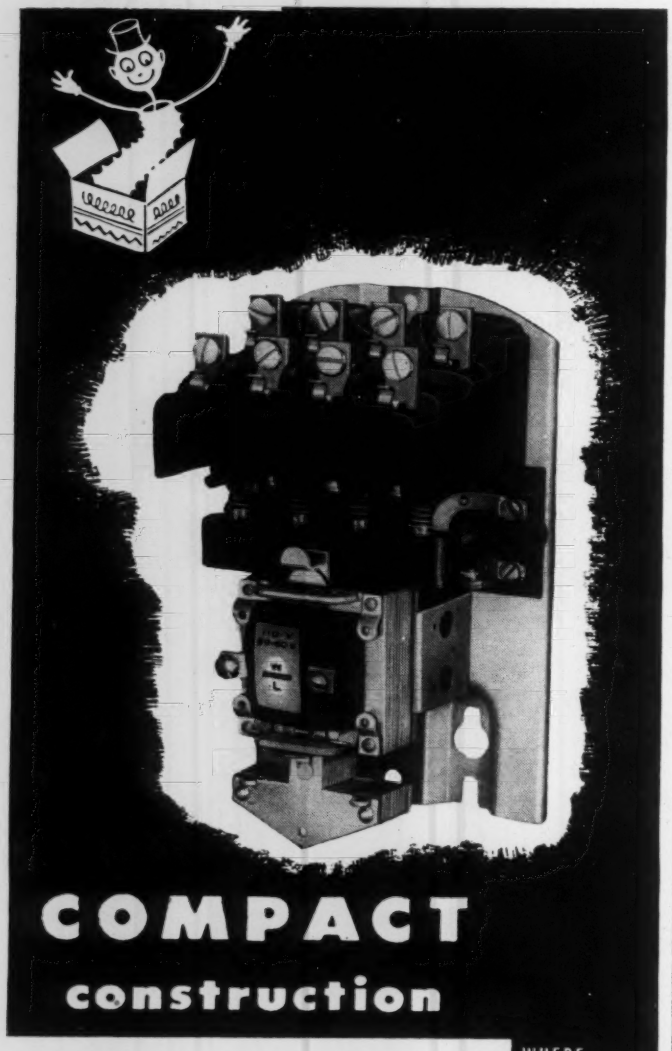


COMPACT
construction

New Contactor has maximum capacity for minimum space, and long life

With a minimum of parts, Ward Leonard's new size #1 a-c solenoid contactor is unusually compact. Assembly in your product is simplified by fact that contactor was designed to meet machine tool requirements. Adaptable to many applications where space is limited. Easy to look at, but doesn't need looking after.

Ward Leonard contactors are "Result-Engineered". By modifying a basic design, Ward Leonard can often give you the results of a special . . . for the cost of a standard.

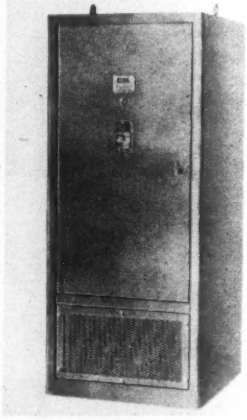
Write for Contactor Catalog. Ward Leonard Electric Co., 24 South St., Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WHERE BASIC DESIGNS IN ELECTRIC CONTROLS ARE RESULT-ENGINEERED FOR YOU

WARD LEONARD
ELECTRIC COMPANY
RESISTORS · RHEOSTATS · RELAYS · CONTROL DEVICES

The steel tube condensing coils, for use with ammonia and "Freon," are tested to 300 psi under water and galvanized after fabrication. Coil surface is 12 sq ft per ton at rated nominal capacity. Other features include the use of a centrifugal (forward curved fan blades) blower, removable strainers, a close coupled centrifugal pump and motor as integral parts of a single unit, self-aligning sleeve type bearings with graphite bronze bushings, and a dripproof fan motor having ball bearings and special tropical insulation for moisture resistance.

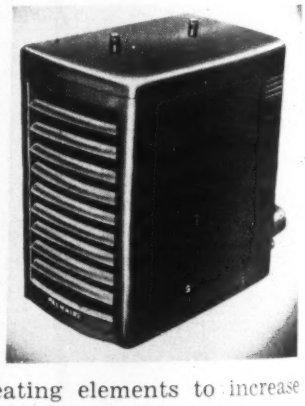
Controls Speed of Magnetic Drive



No. 3726—"Regutron" provides excitation and speed control of boiler draft fans, centrifugal pumps, compressors, and blowers on which magnetic drives are used. It rectifies three phase supply current to energize the magnetic drive and adjusts the current to hold operating speeds to within ±1.0 percent of selected speed. It is available from Electric Machinery Mfg. Co., Minneapolis 13, Minn.

Speed of the load is selected by automatic or manual positioning of a small potentiometer. Other components of this electronic speed control are designed to guard against overvoltage, undervoltage, short time power failure, and improper operation of the tubes or amplifier.

Designs Gas Unit Heater for Commercial, Industrial Use



No. 3727—The Palmer Mfg. Corp., 2200 W. Filmore St., Phoenix, Ariz., is offering a new "Palmaire" 80,000 Btu input, suspended type gas fired unit heater specifically designed for business and industrial heating.

Outstanding features of the new heater are said to include a compact design to permit low ceiling installations, corrugated steel heating elements to increase heat transfer efficiency and reduce operating noises to a minimum, adjustable air deflectors, choice of fan or blower, and easily accessible controls and burners. The heater, which can be equipped with thermostatic control, is AGA approved for natural, liquefied petroleum, or manufactured gas.

All-Steel Construction Used in Extended Surface Heating Element

No. 3728**—The ICR radiator, offered by Stedco Products Co., Kingston, Pa., has an extended surface heating element made entirely of steel. It is made up of 1¼ in.

New Flexible Duct Connector

PASSES 'ACID' TEST!

Unaffected by 6-month exposure to weather, sulfuric acid fumes and constant vibration

Really rugged is the new flexible Fiberglas* duct connector by Bauer & Black. Proof of its endurance may be seen in an unusual application at the Riverdale, Illinois, plant of Acme Steel Co.

Bauer & Black engineers tested the new connector on a huge ventilating stack over a galvanizing bath. Weather, sulfuric acid fumes, and heavy vibration from below had destroyed previously-used connectors in 90 days. But the Bauer & Black connector shows NO SIGN OF DETERIORATION after more than six months.

For elements of the connector, see the diagram. The Bauer & Black Industrial Adhesive Tapes used are unusual and practical because of two unique components:

A. *Backing of Fiberglas* Cloth—thin, super-strong, permanent. Resists heat, light, deterioration. Won't shrink or stretch.*

B. *Vulcanizable adhesive whose strength increases greatly under heat, and whose seal grows stronger with age. Sticks with a touch.*

Speedily installed, the new connector helps cut labor costs drastically. Fiberglas tapes and neoprene-coated fabric handle easily, conform readily, seal instantly, give a neat-appearing, airtight fit. The connector fills a long-standing need in heating, piping and air-conditioning.

WRITE FOR DETAILS

Full information on applications, source and price will be gladly furnished on request. The Bauer & Black flexible duct connector can save you time and money, improve your installations. Address Dept. D8-4 today. No obligation.

HERE ARE THE PARTS OF THE NEW CONNECTOR

1 — *Bauer & Black Industrial Adhesive Tape No. 281—Fiberglas fabric coated on both sides with vulcanizable adhesive. Gives airtight seal that grows stronger with age.*

2 — *Neoprene-coated Fiberglas fabric—sturdy, airtight yet bulk-free.*

3 — *Bauer & Black Industrial Adhesive Tape No. 263—Fiberglas fabric, coated on one side with vulcanizable adhesive. Like No. 281, stubbornly resists deterioration.*

*Fiberglas (Reg. U. S. Pat. Off. by Owens-Corning Fiberglas Corp.)

Products of

BAUER & BLACK

Division of The Kendall Company • 2500 S. Dearborn St. • Chicago 16

Industrial Adhesive Tape

PRESSURE SENSITIVE

Production Short Cuts to Reduce Costs • Research to Speed and Improve Methods

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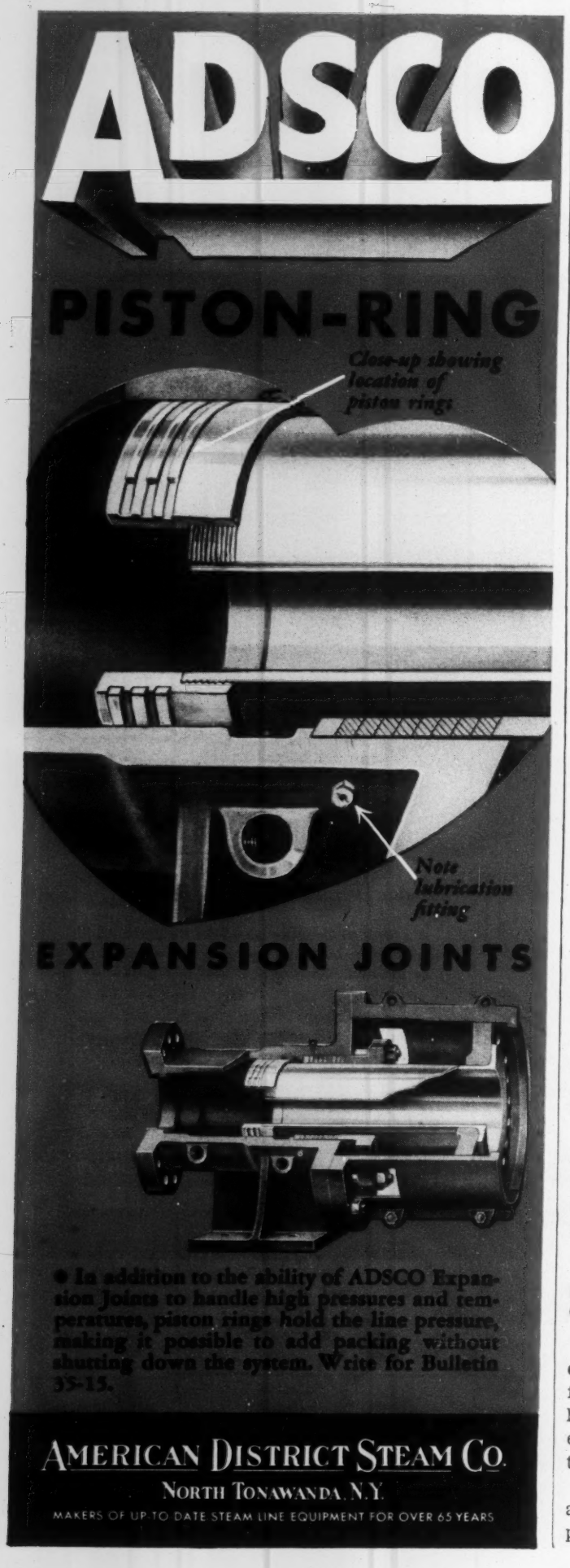
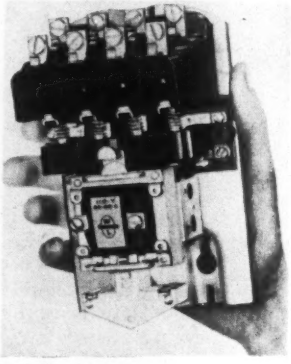

ADSCO
PISTON-RING
Close-up showing location of piston rings
Note lubrication fitting
EXPANSION JOINTS
• In addition to the ability of ADSCO Expansion Joints to handle high pressures and temperatures, piston rings hold the line pressure, making it possible to add packing without shutting down the system. Write for Bulletin 35-15.
AMERICAN DISTRICT STEAM CO.
NORTH TONAWANDA, N.Y.
MAKERS OF UP-TO-DATE STEAM LINE EQUIPMENT FOR OVER 65 YEARS

welded pipe with No. 22 gage fins attached mechanically. According to the manufacturer, the single pipe feature permits working pressures up to 150 psi. The unit is adaptable to two pipe heating systems and is said to function equally well with sub-atmospheric steam. Manufactured in standard lengths from 18 to 72 in., units are threaded at each end with standard pipe threads unless otherwise ordered. One lineal foot of this radiation is said to provide 1676 Btu per hr, based on 215 F steam temperature and 70 F room temperature.

Also available from the company are types CS and BS cabinets of modern design which are built to fit the radiator unit. The type CS unit is designed so that radiator brackets need not be used for support as the heating element is slipped into and supported at each end of the cabinet. Two holes are supplied in the rear of the cabinet to suspend it with wood screws, lag screws, or bolts. The type BS cabinet is designed for installation on the radiator after the heating element has been hung on the wall with brackets.

Offers Electric Contactors For A-C Motor Controllers

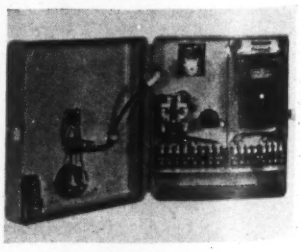


No. 3729—Ward Leonard Electric Co., Mt. Vernon, N. Y., has announced a new development, Bulletin 4451 size 1 a-c solenoid contactors which are designed for use as main line, reversing or accelerating contactors on a-c motor controllers for machine tools, air conditioning equipment, pumps, compressors, etc. They are also said to be suitable for the remote control of heater loads and tungsten or infrared lamp loads.

According to the manufacturer, features include the complete accessibility of all parts, compact unit construction, rapid consistent operation, high arc interruption capacity, long life, and simplicity of installation and inspection. Units are equipped with double break silver-to-silver contacts and the contactor parts are arranged on a steel mounting plate having recommended NEMA standard mounting dimensions.

Available with up to four main poles, these contactors have maximum ratings of 7½ hp, 440 to 550 volts, on 3 phase, 60 cycle circuits. Standard operating coils are available for 110, 220, 440, and 550 volt operation on frequencies of 25, 50, and 60 cycles.

Develops Photoelectric Combustion Control for Commercial Oil Burners

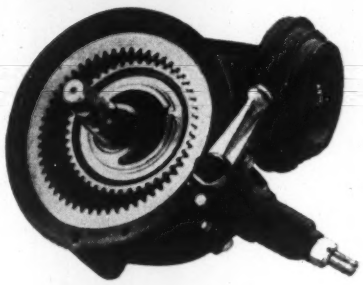


No. 3730*—A new photoelectric combustion system for commercial oil burners has been developed by General Electric Co., Schenectady 5, N. Y.

The unit is composed of a master control unit, a phototube unit, and an

Coal's in the Saddle Again!

. . . and Winkler Money-Saving Efficiency makes its use doubly attractive



NO SHEAR PIN! The Winkler Transmission is *fully automatic.*

Here is the feature which gives Winkler the edge! When the screw load exceeds a predetermined torque, the Winkler Automatic Safety Release disconnects the transmission from the drive shaft, then momentarily re-engages it. If the obstruction is rock or slate, two or three re-engagements will, in most cases, crush it. If the feed screw is permanently locked, the mechanism is fully protected, even though it runs for hours. Upon removal of the obstruction, the Winkler resumes normal operation.

This Winkler slashed coal consumption from
201 to 161 TONS PER YEAR

High prices and shortages in other fuels opens the best profit opportunity in years to men who sell coal and automatic coal-burning equipment. Coal is the *safe, dependable fuel* . . . and burning it in a Winkler Stoker brings heat production down to the lowest cost level.

The following letter explains why Winkler users are enthusiastic boosters—

"We wish to state that the Winkler Stoker purchased from you last year has been satisfactory in every respect. In fact, we learn to appreciate it more as we see it in operation. Furthermore, we wish to thank you personally for the many extra services given us in teaching our janitors its operation.

"Perhaps you would be interested in the following data relative to comparative costs of fuel. During the school year of 1939-40 we used 201 tons of coal with hand firing. With the stoker we used 161½ tons of coal during the past winter. The increased electric consumption was negligible.

"You may feel free to refer prospective purchasers to us or bring them for inspection of our plant."

Very truly yours,
(Signed) R. J. Miller, Principal.

Find out today about the Winkler Assured Profits Program—cash in on today's demand for fuel-saving Winkler Stokers.

Winkler Stokers, with the famous Winkler "Inter-plan" Transmission, cover a complete range of Hopper and Self-feed models for homes, apartments, commercial and industrial buildings.

WINKLER
fully automatic STOKERS

U. S. MACHINE CORPORATION
DEPT. AN-11
LEBANON, IND.
Export Office: 80 Broad Street New York 4, N. Y., U. S. A.

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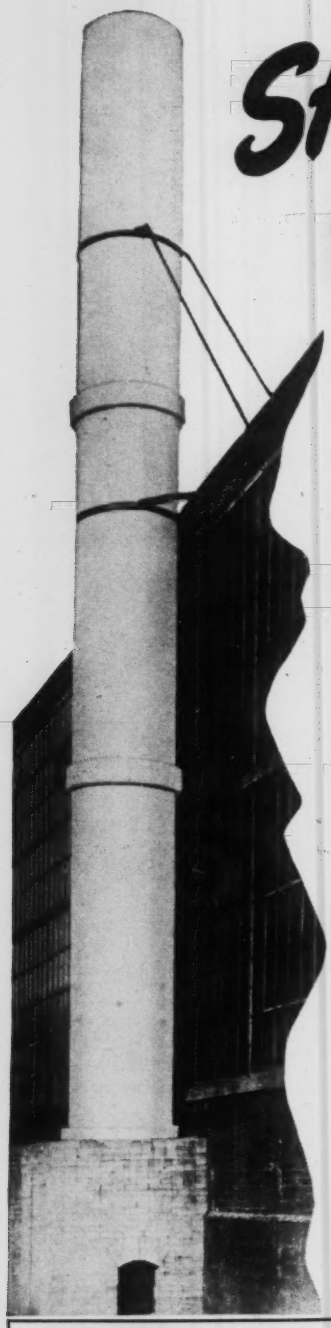


Still on the Job

AFTER MORE THAN 15 YEARS FIGHTING 2-WAY CORROSION

HERE IS ANOTHER EXAMPLE of the type of industrial venting service provided by Transite Industrial Vent Pipe.

For more than 15 years, this Transite stack at the Waterbury, Connecticut, plant of the Chase Brass and Copper Company has been exposed to conditions so severe, that the pipe previously used had to be replaced at frequent intervals. Its interior is constantly subjected to the destructive action of corrosive acid fumes . . . its exterior to the aggressive attacks of weather. Yet, despite this double-barreled attack from corrosion, it has required but very little maintenance *and is still on the job today.*

If you have a venting problem, this asbestos-cement pipe may prove a practical solution. Highly resistant to many of the corrosive gases, vapors and fumes met in industrial operations, it is providing long-term, low-cost performance in many industries. Rustproof and weather-resistant, Transite needs no painting. And it comes in sizes up to 36" in diameter, with a full line of Transite fittings to assure corrosion resistance throughout the system.

Data Sheet Series DS-336 gives you complete details and is free on request. Write Johns-Manville, Box 290, New York 16, N. Y. for your copy.

JM

Typical Industries in which Transite Industrial Vent Pipe is used

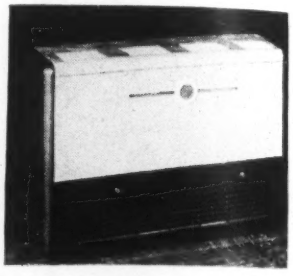
Aircraft	Foundry	Quarrying
Automobile	Furnace	Railroad
Baking	Furniture	Rayon
Bleaching	Gas	Refrigeration
Boiler Works	Glass	Rubber
Brewing	Laboratory	Sewage Works
Canning	Laundry	Shipbuilding
Ceramic	Leather	Shoe
Chemical	Meat Packing	Smelting
Dairy	Metal	Soap
Drug	Mining	Soft Drink
Electrical	Paint	Sugar Refining
Explosive	Petroleum	Textile
Farm Machinery	Potash	Tool
Food	Pulp & Paper	Water Works

Johns-Manville TRANSITE Industrial Vent PIPE

electrode unit. It is designed to shut off the flow of fuel to an oil burner if the oil fails to ignite or if the flame is extinguished after ignition. On gas-electric ignition systems it prevents fuel from flowing if the gas pilot fails to ignite.

According to the manufacturer, the burner motor operates for a definite period after shutdown or combustion failure in order to purge the nozzle or cup of unburned fuel. A complete starting sequence is said to be assured after shutdown of the burner, caused by power failure or low water cutoff, because the system is designed to prevent the oil valve from opening until the program switch recycles.

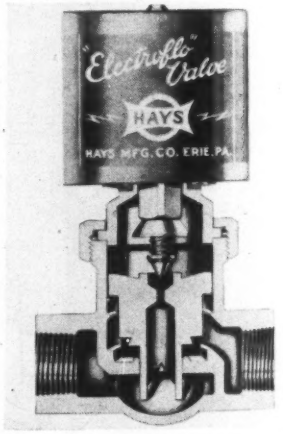
Designs Unit Ventilator for School Classrooms



No. 3731—Now available for heating and ventilating school classrooms is a new unit ventilator offered by Herman Nelson Corp., Moline, Ill. It is designed to permit gradual throttling of steam supply for uniform temperature control by the use of a "floating heating element with steam distributing tubes, a pressure equalizing unit, and condensate cooling surface.

A slow speed, direct connected motor, located in the end compartment out of the air stream, is said to provide quiet operation and to permit the entire cabinet space above the heating element to be used for the fans, the number of which varies with the capacity of the unit to insure uniformly slow tip speed. Other features include the use of welded steel cabinet construction, an automatic back draft damper, a demountable wall intake for weather tight installations and air filters.

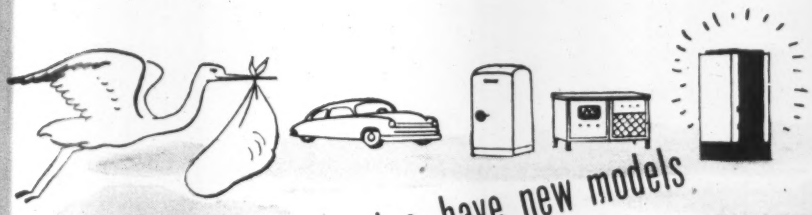
Electric Valve Controls Water, Oil, Steam, and Air



No. 3732—Hays Mfg. Co., 12th and Liberty Sts., Erie, Pa., has developed a new "Electroflo" valve for the control of water, oil, steam and air.

In operation a small solenoid valve is used to control fluid pressure in a valve chamber. When the solenoid valve opens, the pressure in the chamber is released so that inlet line pressure is permitted to raise the main piston from its valve seat, thus permitting the flow of fluid through the valve. When the solenoid valve is closed, supply line pressure is permitted to develop in the pressure chamber above the piston. This causes the piston to move downward and close the main valve.

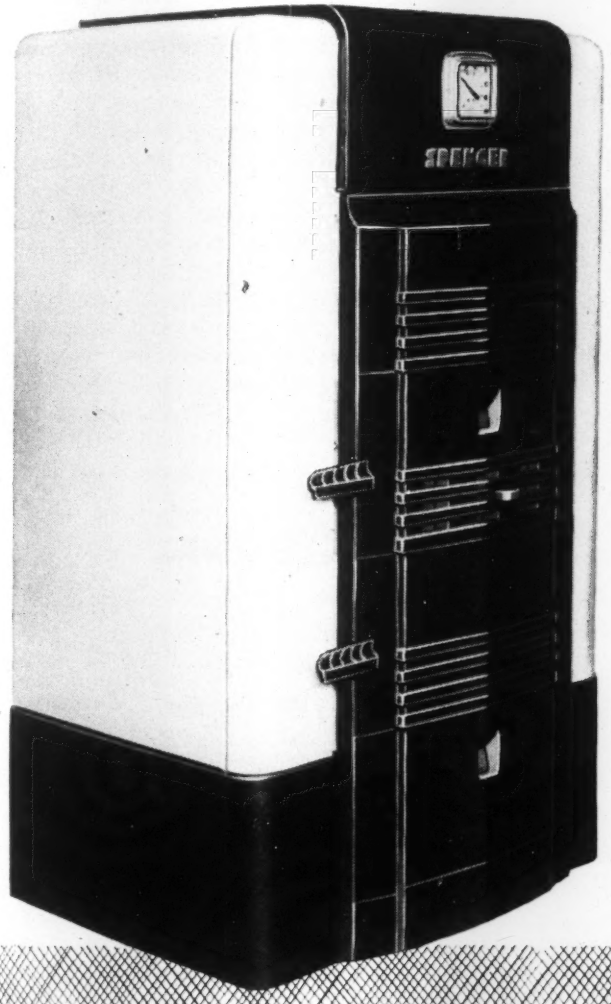
Designed for remote and automatic control, the valve is said to be quick-acting, anti-hammer, and of the packless type.



Boilers, too, have new models

now . . . .

the new, all purpose SPENCER SERIES 21 BOILER



Spencer—known since 1888 for manufacturing only quality boilers—now brings you this splendid new all purpose cast iron sectional boiler. New in design . . . design proven under actual conditions in our testing laboratories. New heights in performance from Spencer's long experience gained in manufacturing quality heating equipment . . . Write today—get complete details.

Just look at these added features—

Designed to burn any type fuel—easily and quickly converted. Year round domestic service hot water. Easily installed—a sectional boiler designed for iron to iron air tight fit. Attractive, colorful jacket combined with modern design door assembly that features pyrex observation ports. Adds a note of beauty to that extra room in the basement.

SPENCER HEATER

DIVISION—AVCO MANUFACTURING CORPORATION
DEPT. HH-2 WILLIAMSPORT, PA.

I-B-R
FULLY APPROVED
REG. U. S. PAT. OFF.

ANOTHER AVCO PRODUCT!

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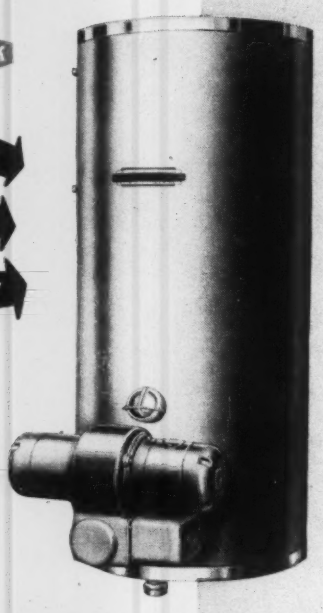
A MULTITUDE OF POSSIBLE USES...

ALDRICH HEAT-PAK PRODUCTS

HOT WATER HEATING

STEAM HEATING

HOT WATER SUPPLY



ALDRICH

BOILER-BURNER UNITS

Residences are *NOT the only places* where these units can be sold. Alert and progressive dealers will recognize a multitude of chances to make good sales in the following suggestions:

COMMERCIAL AND INDUSTRIAL BUILDINGS — Stores, theatres, factories, apartments, etc. For heating and hot water supply, new and replacement installations.

RESTAURANTS — For steam tables and dishwashers.

LAUNDRIES — Commercial and self-service. For heating and all hot water and steam requirements.

HOSPITALS and other **INSTITUTIONS** — For sterilizers, laundry, heating, hot water supply.

INDUSTRIAL PLANTS—For processes such as degreasing. For lavatories, heating, and hot water supply.

GARAGES — For washing and steam cleaning.

DRY CLEANERS — For low pressure pressing machines. The same for clothing manufacturers.

DAIRIES — Any processing requiring steam or hot water.

DON'T MISS THESE OPPORTUNITIES. Look around now for places where you can sell the efficiency, high performance, fast recovery, and economy of Aldrich Boiler-Burner Units.

ALDRICH OIL BURNERS

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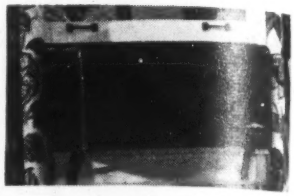
105 EAST WILLIAMS ST., WYOMING, ILL.

Hermetic Unit Used in Window Type Conditioner



No. 3733—A new compact, window type room conditioner for homes and offices has been introduced by Frigidaire Div., General Motors Corp., Dayton 1, Ohio.

Designed for installation in almost any household or office window, the new SRA-50 conditioner is said to provide low cost cooling for rooms up to approximately 250 sq ft. Two or more units are recommended for larger rooms. It fits any double hung window from 29 to 52 in. in width and requires only a plug-in connection to operate. It is powered by a compact "Meter-Miser" refrigerating unit which is hermetically sealed. The entire conditioner is 13½ in. high, 26 in. wide, and 29½ in. deep, and the unit projects into the room 15½ in. when installed.

Circulating filtered air at the rate of 185 cfm, the new unit is designed to cool, dehumidify, and ventilate the room. Angled grilles direct air upward to prevent direct drafts. During the spring or autumn months, the cooling mechanism can be turned off and the unit will continue to ventilate the room with outside air. A three position switch affords room temperature control.

Pneumatic Radiator Valve Controls Steam, Hot and Cold Water

No. 3734—Compact, modern design, a choice of four body styles, and a range of seven port sizes are said to make the type V0501A pneumatic radiator valve ideally suited to the common heating and air conditioning applications where hot and cold water and steam are to be controlled. According to the manufacturer, Minneapolis-Honeywell Regulator Co., 2604 4th Ave., S., Minneapolis 8, Minn., the valves may be used to advantage on most types of convectors and enclosed radiators, where space is often severely limited, as well as on exposed radiators.

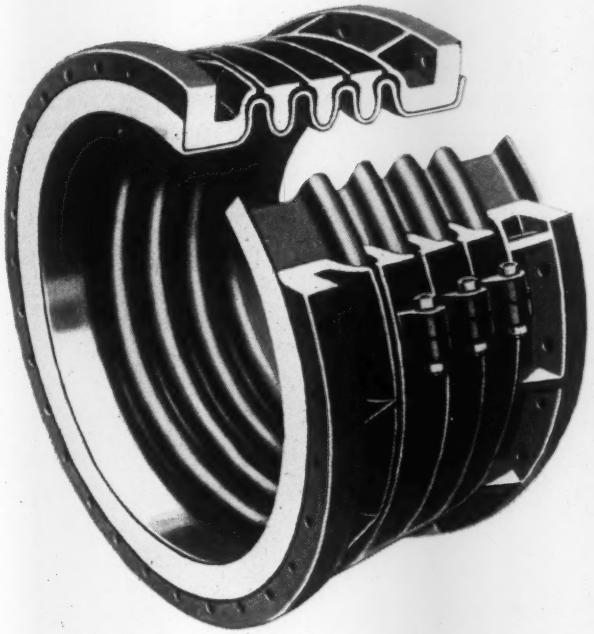
Air at approximately 17 psi is fed from a controller through a flexible tube into a chamber located between a diaphragm cup and the diaphragm. The force exerted by the air pressure is transmitted to the valve stem through the diaphragm plate and the stem plate. A change in air pressure causes the valve stem, guide, and disc to move until forces are again in balance. This changes the opening between the disc and valve seat.

Units are available in ½ and ¾ in. pipe sizes for controlling fluids up to 230 F and 75 psi maximum working pressure. The allowable working pressure varies with the port size used.

Refrigeration Leak Detector Burns Alcohol

No. 3735**—A new refrigeration leak detector outfit, model 1240, has been announced by the Justrite Mfg. Co., 2061 N. Southport Ave., Chicago, Ill.

in expansion joints



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BADGER Self-equalizing Corrugated Expansion Joints should be a "must" on all pipe-line installations.

Because only in *Badger* Expansion Joints are the flexing movement and stresses definitely directed so that:

All points of the surface of each corrugation share its individual load equally, and

All the corrugations share the stress load equally.

With Badger ALL-CURVE Directed Flexing Rings and Badger ALL-CURVE corrugations, excessive stresses can't localize in pockets, corners or junctions, nor pile up unevenly among the corrugations. They can't endanger the line or shorten the life of these superbly engineered joints.

Special Badger methods of forming the corrugations from a single piece of tubing contribute further to the strength of these joints, and a special Badger heat treatment preserves their flexing qualities.

Each corrugation affords a definite standard of traverse, according to its depth and the diameter of the joint. This makes it easy to determine the number of corrugations required to absorb the maximum expansion of any length of line.

When you install dependable, long-lasting Badger Self-equalizing Corrugated Expansion Joints, your pipe-expansion problems are solved.

MADE IN COPPER, STAINLESS STEEL AND OTHER ALLOYS — Copper for normal pressures and temperatures; Stainless Steel and other alloys for higher requirements—and where corrosion is a prob'em. Single or multiple corrugations—for traverses from a fraction of an inch upward. Also made in Non-equalizing type (without rings) for uses that do not require added protection. Send for Bulletin No. 100 (*Self-equalizing*) or No. 200 (*Non-equalizing*).

Badger

PACKLESS CORRUGATED EXPANSION JOINTS

E. B. BADGER & SONS CO., 75 Pitts Street, Boston 14, Mass.

AGENTS IN PRINCIPAL CITIES

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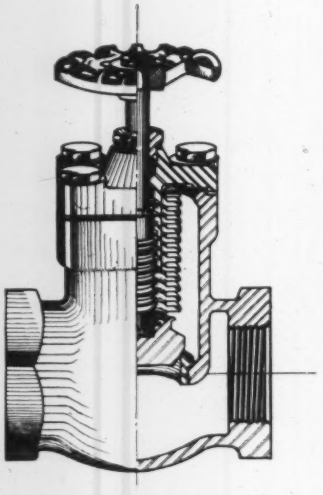
Designed to burn alcohol, the new detector is said to be a compact unit for locating leaks in refrigeration systems using halide gases. However, the device may also be used as a soldering iron and as a blow torch (soldering point and flame reducer included in the outfit).

The detector develops 140 psi pressure at 1800 to 1900 F and burns from 20 to 45 min on 1½ oz of fuel.

Packless Valve Available in Stainless Steel

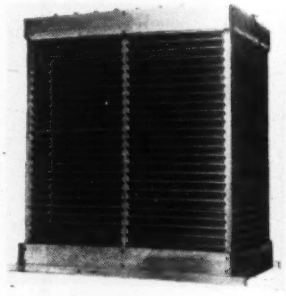


No. 3736—A new type packless valve, No. 3000 Series, said to be suitable for numerous applications, has been developed by Fulton Sylphon Div., Dept. P-V, Robertshaw-Fulton Controls Co., Knoxville, Tenn.

Leakproof performance and freedom from maintenance are said to be provided by the seamless metal bellows used between the valve disc and the valve body. A new feature of these valves is that they are available equipped with stainless steel bellows and stainless steel bodies, making them suitable for use where corrosive and other metal wearing actions are encountered. The bodies of the valves are also available in bronze, cast iron, cast steel, or monel. The bellows is available in either stainless steel, monel, phosphor bronze, or brass. For high vacuum service, a composition disc is used in lieu of a metal disc.

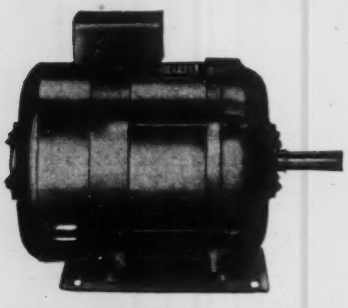
According to the manufacturer, the valves are applicable to temperature services up to 300 F in the screwed end type. For temperatures from 300 to 700 F a yoke and external thread construction is used, and by special construction, they may be made suitable for temperatures up to 1200 F. They are made in sizes from ¼ to 3 in. with screwed, welded, or flanged ends.

Design Improvement Featured in Small Natural Draft Cooling Tower

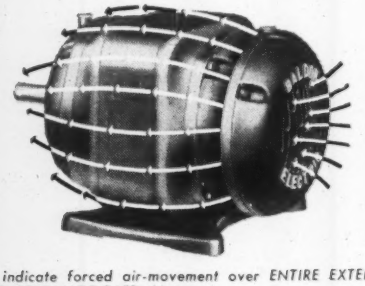


No. 3737—A small natural draft cooling tower, series 100, which is said to embody the engineering design, balanced spray system, and predetermined performance found in large towers, has been announced by The Marley Co., Inc., Kansas City 15, Kans.

The tower, offered in six frame sizes from 4 to 36 tons refrigeration capacity, depending upon local wet bulb conditions, is now in production. The new design features are said to include the use of California redwood lumber, galvanized hardware, and machined louver posts without nails, bolts, or back-



Open, drip-proof construction; 1/6 to ⅓ h. p., 1 phase, 3 phase and Direct Current.



Arrows indicate forced air-movement over ENTIRE EXTERIOR of BALDOR STREAMCOOLED Motor.

Single Phase, ¾ to 7½ h. p.
3-Phase, 1 to 20 h. p.
Direct Current, 1 to 3 h. p.

STREAMCOOLED, round frame, ⅓ to ¾ h. p., 1 phase, 3 phase and Direct Current.

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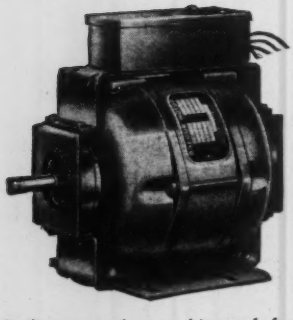

Resilient-mounted, open, drip-proof, for belt drive; 1/10 to ¾ h. p., single phase.

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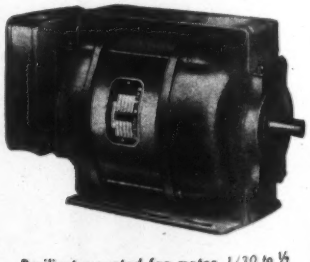
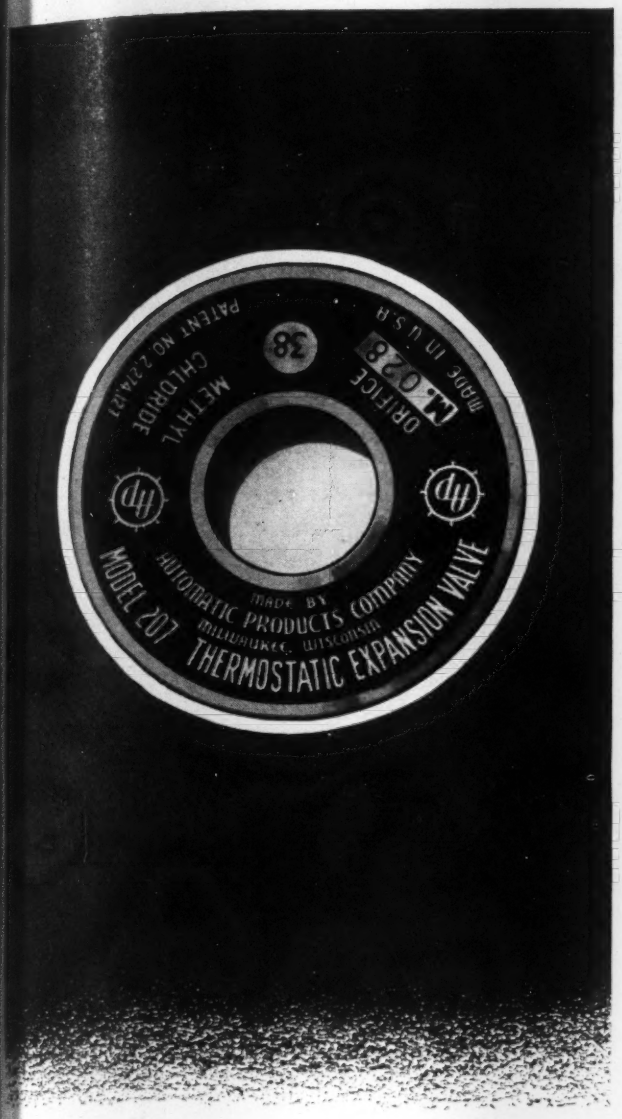
BETTER MOTORS
FOR MORE THAN A QUARTER CENTURY



Resilient-mounted fan motor, 1/30 to ½ h. p., 1 phase; ⅓ to ½ h. p., 3 phase.



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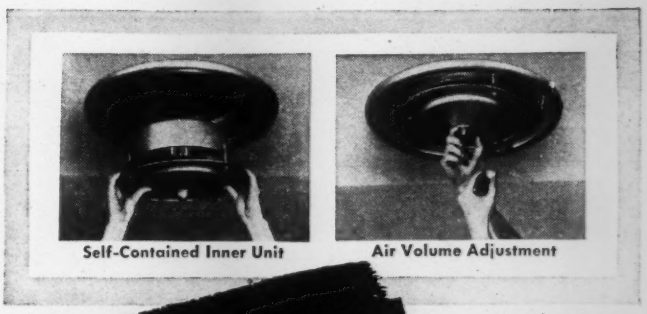

FAST INSTALLATION

"Custom-made" air pattern with Kno-Draft Adjustable Diffusers in Champion Spark Plug Plant

PROBLEM: A ceramic kiln radiates heat on one side and a cold window-filled wall creates drafts on the other. The space is long and narrow with low head room. The occupants work in short sleeves. Unusually large volumes of supply air have to be brought in to combat the heat of the kiln. Space for duct work above the room is limited so that diffusers have to be spaced much closer than usual. The supply air stream has to be directed slightly above the horizontal and evenly distributed so that no drafts are felt by the personnel.

SOLUTION: Kno-Draft Adjustable Air Diffusers were chosen because of their ability to control air direction, volume and throw. A "custom-made" air pattern was created which thoroughly mixed room and supply air, maintained uniform temperature throughout and eliminated drafts, hot spots, and cold spots. *Installation* was fast. Kno-Draft self-contained inner units cut installation time up to 50%. *Balancing* was fast. CFM readings were taken directly with Velometer. A twist of the wrist changes air volume on each diffuser.

Free — New handbook on Air Diffusion

It contains the latest engineering data on air diffusion and is profusely illustrated with charts, photographs, sketches and dimension prints that simplify the selection, application, location, assembly, erection, testing and adjusting of Kno-Draft Adjustable Air Diffusers. It is designed to help you get top efficiency from an air conditioning system by creating "custom-made" air distribution patterns.

For your FREE copy, please write Dept. D-10

W. B. CONNOR ENGINEERING CORP.

Air Diffusion • Air Purification • Air Recovery

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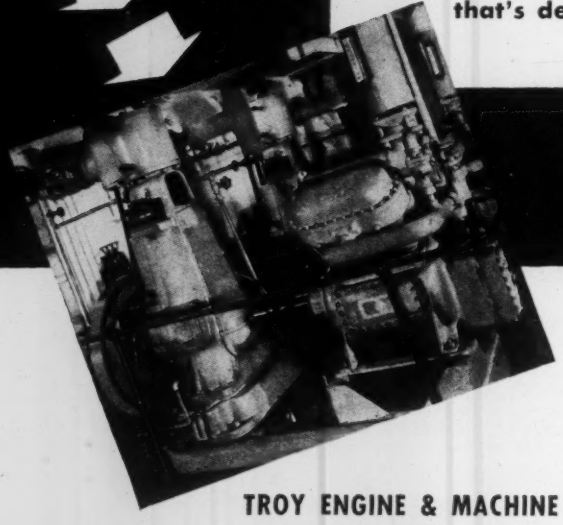
Nothing can beat the standard counter flow steam engine when it comes to producing consistently dependable and economical power. For your air conditioning and refrigeration compressors or ventilating fan, Troy-Engberg Steam Engines offer a drive that really fits the requirements: low speed, wide speed range, and minimum down time for overhaul and repair.

There are hundreds of Troy Engines that have been driving compressors and other equipment for more than twenty-five years and longer without need for major repairs. For real drive economy and drive dependability use a Troy-Engberg Steam Engine. Its low cost power that's dependable.



TROY ENGINE & MACHINE COMPANY
(Established 1870)
2200 Railroad Avenue Troy, Pennsylvania

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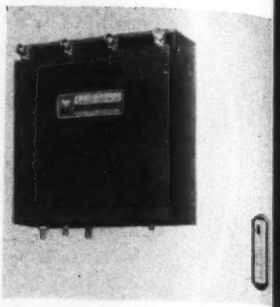
STEAM ENGINES • GENERATING SETS • GENERATORS

up strips. The spray system is designed to give maximum breakup at lowest pressure and to give a balanced spray in all areas of the tower. The company's patented bronze spray nozzles are said to give maximum efficiency at the specified flow. The towers are prefabricated and shipped "knocked down" with each member piece marked and with erection, operation, and maintenance instructions included.

Humidifying Unit Is Self Contained



No. 3738—Designed to atomize 35 lb of water per hr using 5 cfm of atomizing air supplied at 32 psi, a new self contained humidifying unit has been developed by Spraying Systems Co., 4033 W. Lake St., Chicago 24, Ill.

The compact unit consists of four humidifying nozzles, water tank with float valve, water strainer, air filter, air regulator with pressure gage, and solenoid operated valve. As a part of this unit a humidistat for automatic control is included, and the device is supplied ready for connection to an air line, water line, and electrical circuit. Nozzles are individually adjusted so that the direction of the sprays may be set as required.

Provides Automatic Starting and Programming Control for Oil Burners

No. 3739—"Fireye" programming control type 24-PJ8 is designed to provide automatic starting and programming control for commercial and industrial oil burning equipment. The manufacturer is Combustion Control Corp., 77 Broadway, Cambridge 42, Mass.

The control is used with the company's photoelectric flame failure scanner type 45PH5 which is designed to protect the oil burning installation from the hazards of flame failure. The control automatically starts a burner in operation and programs a sequence of fuel valve opening, post-ignition time, priming, and scavenging.

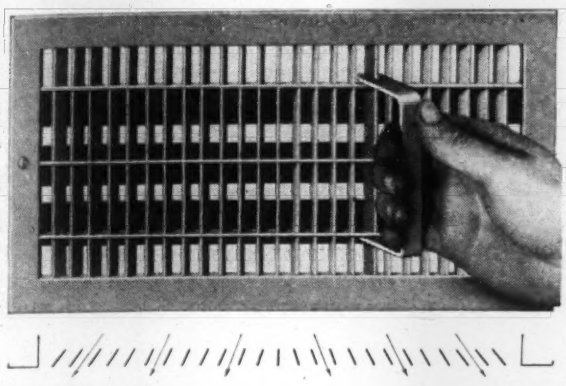
Incorporating numerous design features, the control handles timing cams which are driven by a specially designed high torque synchronous motor. The unit is designed to operate on 115/230 volts, 60 cycle current and is rated at 1 hp. The scavenging period is 23 sec, the fuel valve delay may be adjusted from 5 to 30 sec, and the post ignition period may be set between 30 and 80 sec.

Condensate Return System Eliminates Individual Steam Traps

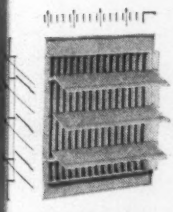
No. 3740—Individual traps on steam and shop lines are said to be eliminated by the new condensate return system which is designed to provide a constant flow of steam and rapid return to the boiler of high tempera-

INDEPENDENT

"Fabrikated" WALL GRILLES WITH DEFLECTING VANES



Style 321-A grille with deflecting vanes



Rear view showing adjustable deflecting vanes

ACCURATE and positive compound deflection of air flows can be readily secured with these "Fabrikated" grilles. Directional adjustments may be made when grilles are installed; or grille bars and vanes may be adjusted after installation to meet unforeseen or changed requirements.

Each grille bar and each deflecting vane is adjusted *individually* with a special two-pronged tool included with each shipment. Locking of grille bars and vanes is not required because they are held firmly in place — no vibration — no rattle.

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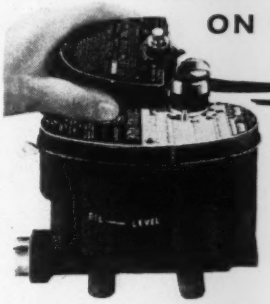
THERMOSTATIC HEAT REGULATOR SET

Now, while your heater customers are totaling last season's heating costs, is the time to suggest installing an A-P THERMOSTATIC HEAT REGULATOR Set. You can promise substantial savings, plus the added comfort of steadier room temperatures, with this set on any vaporizing burner oil heater using A-P Safety Oil Controls. This includes new heaters as well as those made since 1939 — using A-P Controls No. 240-Y, U, or D series.

Here's a rich accessory sales opportunity — with a prospect list you've been building up for EIGHT YEARS . . . Heater owners waiting and watching for AUTOMATIC Temperature Control to truly modernize their vaporizing burning oil heaters.

SIMPLE TO INSTALL ON NEW OR OLD HEATERS



Just mount Electric Conversion Top on present A-P Manual Control. Then connect to modern Wall Thermostat and Transformer. "Sales Package" contains all accessories.

WRITE for complete Selling Material on A-P Oil Control Accessories — including A-P Thermostatic Heat Regulator Sets, Oilifter Automatic Fuel Handler, and Fuel Oil Trap-It.

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HUNDREDS of Layne Well Water Systems are now serving the Nation's largest railroads. And only in these systems have maintenance engineers found the rugged quality, long life and high efficiency that creates such unmatched reliability. Layne is proud of this splendid tribute to their years of sincere craftsmanship.

But railroads are not alone in this acknowledgment of water system superiority. The same preference applies to thousands of installations for cities, factories, dairies, chemical plants, petroleum refineries and irrigation projects.

The buying of a Layne Well Water System automatically obtains the very best of everything:—Layne skill in modern well drilling;—the correct type of screen and its proper installation;—the proper pump for sustained economical service;—and the final tests to prove that the system is thoroughly efficient in its operation.

For literature on Layne Well Water Systems address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

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ture condensate. The manufacturer is W. [illegible] Acker Organization, 3167 Fulton Rd., Cleveland, Ohio.

The system, which is also adaptable to the handling of process liquids, accumulates condensate by gravity and returns it to the boiler at temperatures ranging up to 350 F. All water fed to the boiler through this system is said to be deaerated by effective liberation of free oxygen and noncondensable gases.

Systems are available for steam pressures up to 250 psi and are manufactured in a range of sizes from 10 hp and up.

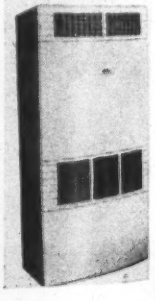
Tool Kit Facilitates Air Conditioning, Refrigeration Repairs

No. 3741*—A new all purpose tool kit, said to facilitate the installation and repair of many air conditioning and refrigeration jobs, has been announced by Ingersoll-Rand Co., 11 Broadway, New York 4, N.Y.

The kit is compact and portable and includes the company's new electric impact tool and standard accessories. With this kit, says the manufacturer, the mechanic may easily and quickly perform the following jobs: nut running and nut removal; drill steel, masonry, and wood; ream, apply, and remove studs; tap, drive, and remove screws; extract broken cap screws and studs; and do hole saw and wire brush work. The impact tool, weighing 6½ lb, is said to save as much as 90 percent time on virtually all service jobs.

The kit is assembled complete or with accessories as required. Shown here is a completely outfitted kit containing all standard equipment plus twist drills, reamers, taps, carbide tipped masonry drills, hole saws, screw and stud extractors, wood bits, and wire brushes. The kit also contains screw drivers, a quick change chuck, Phillips bits, Reed and Prince bits, and a screw driver adapter for these bits. A universal joint and anvil extensions are also available.

Hermetic Refrigeration Unit Used in Packaged Conditioner

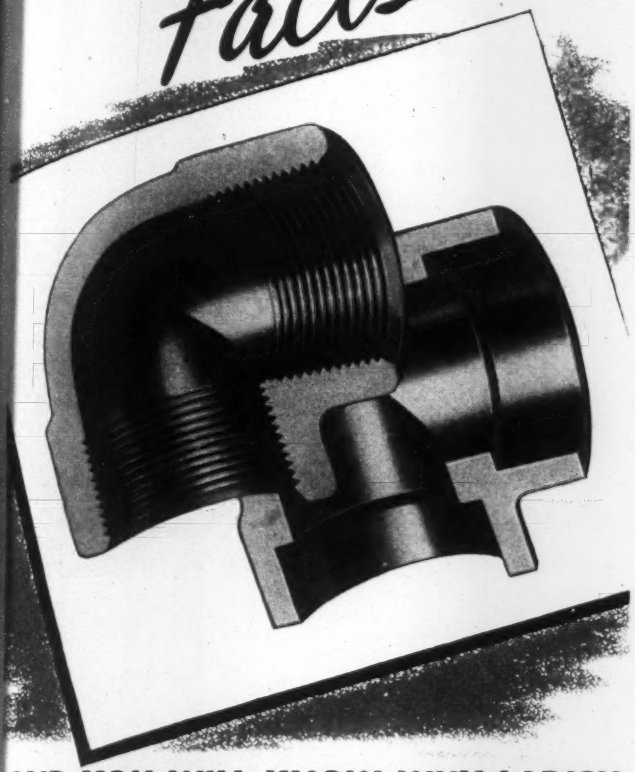


No. 3742—A newly redesigned "usAIRco" packaged air conditioning unit that cools, dehumidifies, filters, circulates, and ventilates has been announced by the United States Air Conditioning Corp., 33rd & Como Ave., S.E., Minneapolis 14, Minn.

This compact, conditioning unit is available in 3 and 5 ton capacities and is ready for installation directly in the store or office area to be cooled. If desired, a remote installation of the unit may be made, distributing the conditioned air through a duct system. For larger areas, multiple installations can be made to take care of the greater cooling requirements. There are three connections to be made; elec-

GET ALL THE

Metallurgical Facts...



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Fact Controlled grain flow provides maximum resistance to shock, strain and stress.

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Ample Stocks... Prompt Service... Carbon, Stainless and Alloy Steels ⅛ through 4 inches, 2000 through 6000 pounds.

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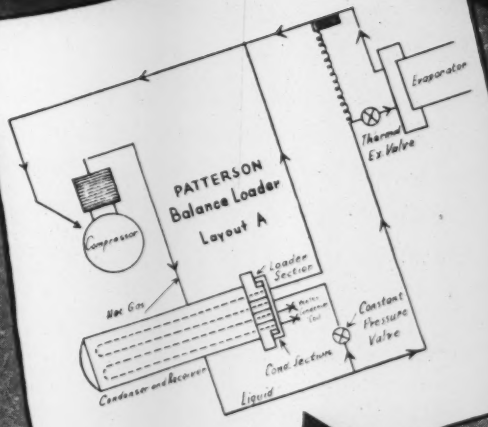

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Featured by . . . Simplicity . . . Efficiency . . . and Complete Modulating Effectiveness from 0% to 100% full load. Acaptable to all variations in Refrigeration Systems.

In writing for further details, give information on capacity and evaporator temperature desired and a description of the system. The Patterson Balance-Loader can be installed in existing systems.

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saves you time and muscle...and pipe

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WORK-SAVER PIPE TOOLS
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trical, water supply, and the necessary drain piping.

A new hermetically sealed compressor-motor unit is used and coils and "Freon" refrigerant lines are of all-welded construction. Air filters are of the throw-away type and the welded steel cabinet is insulated against mechanical noise and heat.

By turning the control dial to "Fan", only the fan is put into operation and the unit functions as a ventilator. For winter use, the unit may be equipped with heating coils to operate as a warm air heating system. Operation of the unit is fully automatic, and can be adjusted for individual preferences.

High Pressure Control Valve Handles Small Flows

No. 3743—The "Microflo" control valve with spline plug is designed to handle small flows measured in cubic centimeters with pressure drops in thousands of pounds. Basic element of the valve is a solid stellite valve plug which is a honed fit in a solid stellite seat. Clearances between the plug and seat cannot be measured by ordinary methods, yet galling does not occur because of the type of metal used, according to the manufacturer, Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I.

This valve can be provided in any body size of ½, ¾, or 1 in. There are 15 interchangeable valve plugs for seats numbered from 1 to 15. In the event new operating conditions require a valve with different capacity, it is only necessary to back out the threaded retainer and replace the plug and seat with another one of the proper trim size.

Rotary Sprinkler Cools Roofs

No. 3744—Ruppright's Rotary Roof Cooler Co., P.O. Box 6795, Los Angeles 22, Calif., has developed a unit for sprinkling water on roofs of factories, markets, terminals, garages, warehouses, showrooms, etc. It is designed to remove heat from the structure by evaporation of the water and is said to be effective when used alone or when used in conjunction with air conditioning.

A jet of water from the nozzle impinges on the vanes of a rotating water wheel which is used to divide the jets into drops falling on a narrow sector of the roof. The spinning wheel also rotates the device on its support through gears, causing the spray to cover the roof surface gradually. This is said to result in a thin film of water being continuously applied.

Equipment Shorts

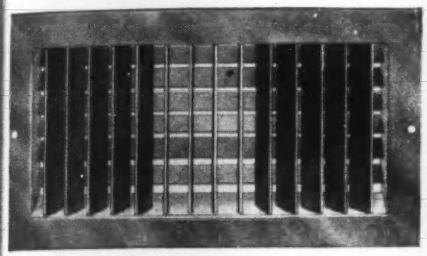
The Trane Co., La Crosse, Wis., manufacturer of heating, cooling, and air conditioning equipment has completed plans for the construction of an eastern branch factory at Scranton, Pa. As soon as it is completed, the new plant will be used for the production of convector-radiators, though other products produced by the company may be fabricated there at a later date. According to the company announcement, the establishment of an eastern branch factory will move a portion of the production closer to eastern markets and raw material sources. This move is part of a program for reducing

YOU CAN GET IT QUICKER FROM Stewart

—and Quickly Discover What's Newest in High Velocity Outlets

Fast deliveries are typical of the progressive merchandising policy which keeps the Stewart line of Outlets, Scoopaires, Wall and Baseboard Registers, ahead of the field. Completely re-designed, they offer you and your customers extra advantages in smart, modern appearance, more efficient diffusion and simpler adjustments. You'll find all popular types and sizes in the Stewart line—for air conditioning, heating and ventilating. Or if you require something special, we'll make it.

PROMPT DELIVERIES ON STANDARD SIZES



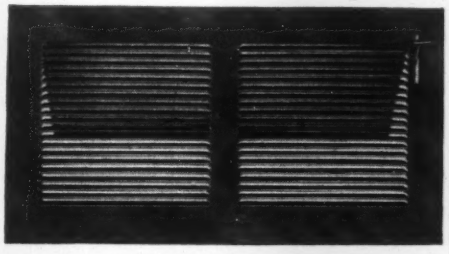
STYLE DDV

(2 Banks) Individually Adjustable Face and Rear Bars

Style DDV is one of 8 variations of Stewart High Velocity Outlets. By means of a detachable key, all bars are adjustable for directing air straight and at various right-left or up-down angles. Style DDV has vertical face bars and horizonal rear bars. Style DDH (not shown) has horizontal face bars and vertical rear bars. This type of outlet is made in popular sizes with or without lever-operated, multiple volume valves. Matching intakes are available. OUTLETS CAN BE SUPPLIED TO FIT CONTOURS OF CABINETS FOR ROOM COOLERS.

STYLE 91

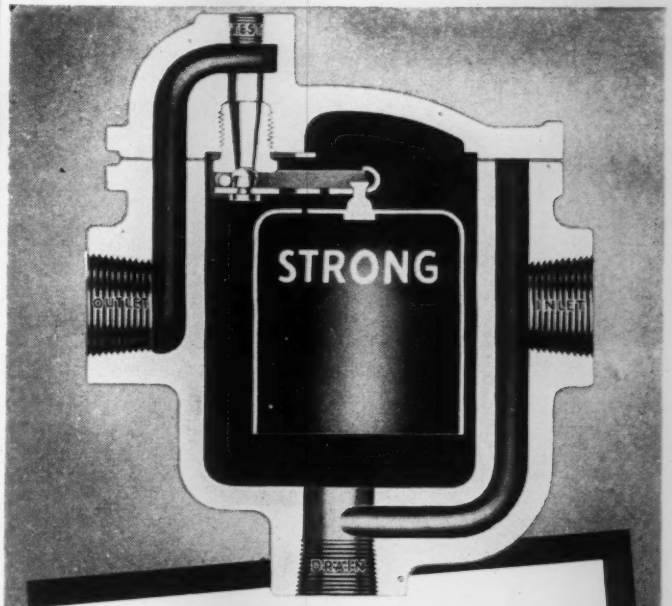
Lever-operated Single Damper Wall Register



STYLE 91 is from the series 70-90 of Wall and Baseboard Registers made with single dampers, or multiple-valve dampers, both lever operated. Face bars of the 90 series are horizontal and set at a down angle. Face bars of the 70 series are vertical, set straight. Setting keys are furnished for user to alter bar settings. Matching grilles are available.

Send for literature and prompt quotation on your requirements

Stewart
MANUFACTURING COMPANY, Inc.
612 BLOOMFIELD AVE., BLOOMFIELD, N. J.



5 Reasons STRONG* 70 Series Traps give better service!

Look to these five reasons for long, trouble-free service in STRONG 70 Series Traps:

1. *Valve and seat guaranteed leakproof for one year*—made of STRONG's patented, wear-resistant Anum-Metl;
2. *Easy servicing*—permitted by the renewable seat design, cover with all working parts easily removed without breaking pipe connections;
3. *One piece bucket*—stainless steel, no welds;
4. *Turbulence avoided, choking minimized, 25% greater capacity*—with STRONG's exclusive Hi-Cap orifice;
5. *No dribbling, quick, full opening*—high ratio leverage.

STRONG *in-line* 70 Series Traps are available in sizes from ½" to 1", semi-steel construction. STRONG's "two-in-one" blast trap with integral thermal air vent is also available in the 70 Series (see cut below).

Catalog No. 67 describes these traps in detail along with other STRONG traps. Write today.

*Trademark Reg. U. S. Pat. Off.

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Cleveland 13, Ohio

ANUM METL Reg. Trade Mark

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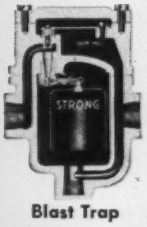
Reducing Valve



Blast Trap

Strainer

STRONG

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ALL MADE TO FUNCTION IN HARMONY BY THE SAME MANUFACTURER

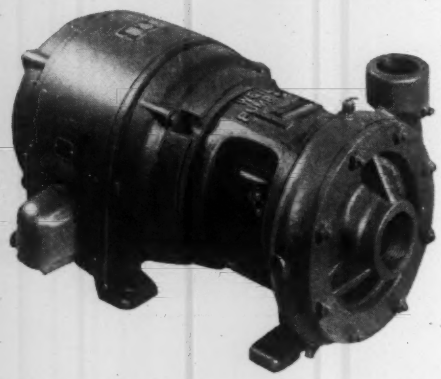


FIG. R 5506

This Single-Shaft PUMP and MOTOR UNIT is an all ball bearing unit with none of the bearings in the casing. Bearings are sealed against dirt and require only one lubrication a year. Sizes with capacities from 10 to 750 G.P.M. Made in 2 types. Type R.U. with packed Stuffing Box for Cooling Tower service. Type RY with leak proof Mechanical Seal for Hot or Chilled Water Circulating.

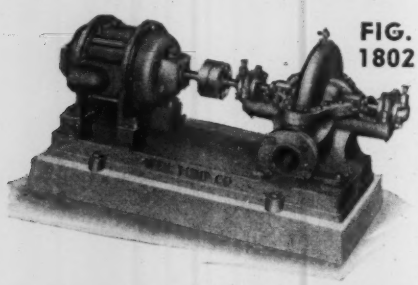


FIG. 1802

High efficiency, Double Suction Pump with Horizontally Split Case. Performs the same services as Fig. R 5506 Pump and is used where greater volume is required. Capacities from 50 to 1200 G.P.M. and heads to 250 ft. Also designed for Booster Service.

For the heating system this Vertical Underground Condensate pump and receiver is supplied either Single or in Duplex as shown. Receivers may be Cast Iron or Steel. We also make the Horizontal type for Low Pressure, known as TVC 300 and SRC 450.

FIG. NRG 2001

Bulletins Are Available From Your Jobber or Our Factory

Fig. R5506, see Bulletin R5500

Fig. 1802, see Bulletin A1800A

Fig. 2001, see Bulletin NRG200A

Horizontal Condensate Pumps —see Bulletins TR100B and RC500A

WEIL PUMP COMPANY

Manufacturers of Centrifugal Pumps

1523 N. FREMONT CHICAGO 22, ILLINOIS

Equipment Shorts (Cont.)

costs and stepping up deliveries. Construction is scheduled to begin immediately.

In its annual report to the stockholders, Fairbanks, Morse & Co. reported 1947 net sales of $89,564,599.98 which is by far the largest peace time volume in the company's history. The net profit for the year after taxes was $4,224,777.07 or $7.05 per common share as compared with $5.14 per share in 1946. According to the report, signed by R. H. Morse, president, orders received from customers in the first six weeks of 1948 are running somewhat larger in total than those received in the comparable period last year.

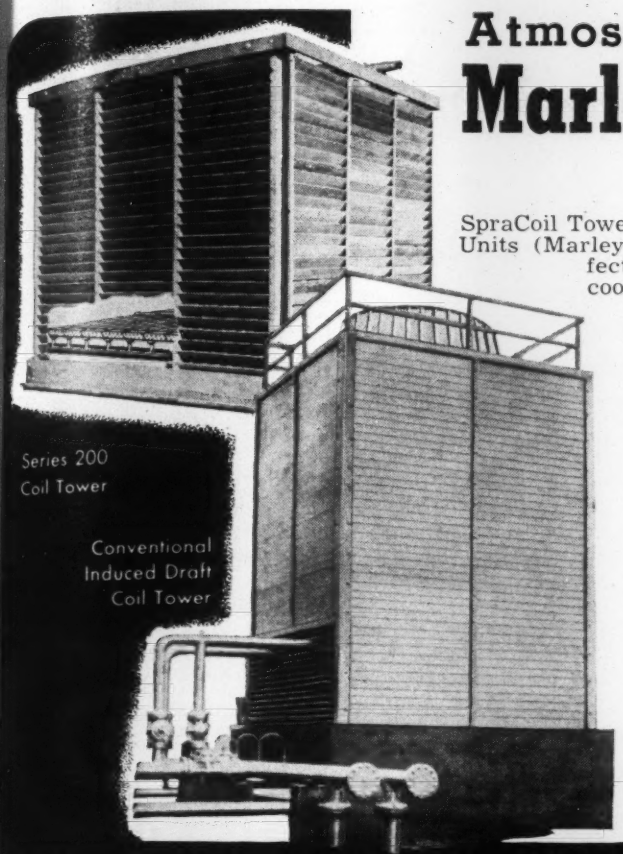
Reductions of 10 to 20 percent in the list prices of "Streamline" solder type fittings for heating, piping, and refrigerating have been announced by Mueller Brass Co., Port Huron, Mich. According to F. L. Riggin, Jr., general sales manager, "this reduction is made in the face of the largest demand and production in the history of the solder type fitting."

Despite the increased demand, delivery time for picture window sizes of the double glazed, insulating "Twindow" units has been reduced to about two weeks according to Pittsburgh Plate Glass Co. Additional production facilities and standardization of sizes has made it possible to assure delivery in about 14 days. The unit is made of two or more panes of glass separated by a hermetically sealed air space and protected by a stainless steel frame. It can be installed in various types of sash and is available in 26 standard sizes.

A 100 percent increase in the rated life of the WL-794 "Sterilamp" ultra-violet lamp—from 2000 to 4000 hr—has been announced by Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J. This improvement in life performance is due principally to modifications in the electrode design, improved manufacturing techniques and more thorough quality control supervision.

Gas fired counterflow heaters, manufactured by Dravo Corp., Pittsburgh, have been listed by the Underwriters Laboratories, Inc., and approved by the American Gas Association. Oil fired models of the same heaters are also listed by the Underwriters Laboratories. The heaters, used principally for industrial and commercial structures, have outputs ranging from 400,000 to 2,000,000 Btu per hr and can be converted to use either gas or oil. Stainless steel combustion chambers are featured.

A fun and fellowship meeting to honor 38 employees with an aggregate total service record of more than 1000 years, and timed to coincide with the opening about May 1st of a newly constructed section of the company's building, has been announced by Vapor Heating Corp., Chicago, manufacturer of railway train heating equipment, steam generators, and "Rador" automatic temperature controls used in streamlined trains.



Atmospheric and Induced Draft

Marley SpraCoil Towers

FOR CLOSED SYSTEM COOLING OF LIQUIDS, OILS AND GASES

SpraCoil Towers are the logical combination of two service-tested Marley Units (Marley Towers and Marley atmospheric sections) into one perfectly coordinated installation. For indirect and combination cooling, SpraCoil Towers set performance standards in a wide range of plants. For years they have rendered the ultimate in service for:

DIESEL PLANTS — Cooling jacket water and lube oil.

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REFINERIES — Cooling or condensing oil, water and volatiles.

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Recycling and Natural Gasoline Plants, Compressor Stations, Smelters and Mines

The Marley Double-Flow Tower with the Marley coil shed also is adapted to high-efficiency coil cooling for largest installations.

THE MARLEY WAY is the PERFECT SPRAY

Marley Non-Clog Spray nozzles boost efficiency in any cooling unit. For peak performance modernize present equipment with these patented nozzles.

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OIL BURNING EQUIPMENT

You Can Recommend with Confidence

FOR PERFECT HEAVY OIL BURNING UNDER ALL OPERATING CONDITIONS

Ace UNIFLOW OIL BURNERS
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Capacity Ranges

	GALLONS PER HOUR	BOILER H. P.	SQUARE FEET STEAM RAD.
MINIMUM	2	6	800
MAXIMUM	165	500	64,000

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Above: "VULCAN". 4 sizes for pipe 1/8 to 8 inches.

At right: "VULCAN SUPERIOR", with reversible jaws and adjusting handle on top. 2 sizes for pipe 1/8 to 4-1/2 inches.

"Vulcan", the original chain pipe vise, is made entirely of tough, wrought steel ... no cast parts whatever. The dropforged jaws are of saw-tempered steel for file sharpening ... chains are of the same high quality as Williams' "Vulcan" Tongs. Fully guaranteed, and sold by Industrial, Plumbing and Oil Field Distributors everywhere.

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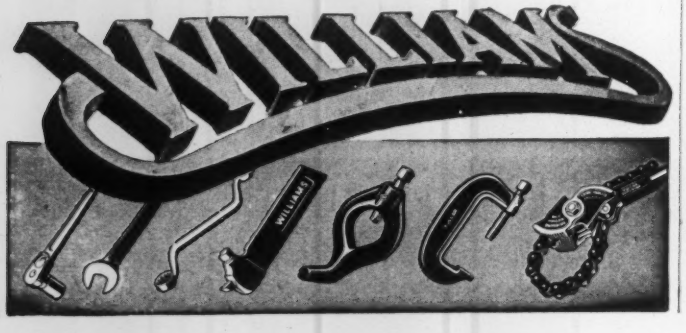


Equipment Shorts (Cont.)

The MagniLastic Div., Cook Electric Co., Chicago, has announced a price reduction of 15 percent on its packless expansion joints in the 55, 150, and 400 series. According to the company this price adjustment has been made possible by improvements in production methods, tooling, and general shop efficiency.

The largest expansion in the history of U. S. Electrical Motors, Inc., Los Angeles, is taking shape in Milford, Conn., where the company's Atlantic plant is now being more than doubled in size. Substantial increase in business and the continued postwar demand for the various types of electrical equipment made by the company have necessitated this extensive expansion program. Construction is now under way and it is expected that the enlarged facilities will be completed next June without interruption of manufacturing.

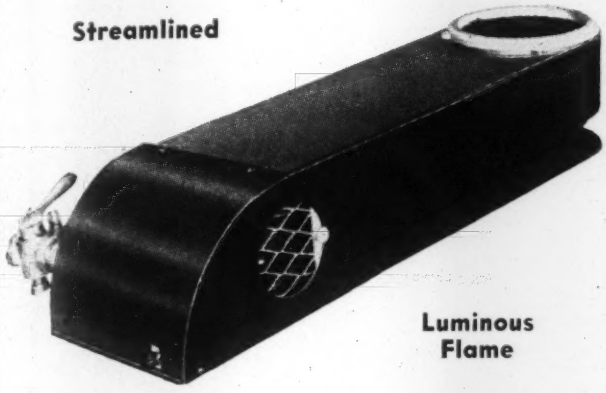
Rapidesign, Inc., P. O. Box 592, Glendale, Calif., has announced a new "Radius Master" No. 76, which is a drafting tool for the rapid and accurate drawing of radii. It is said to eliminate the old trial and error method and to locate the radius point by the center hole serving the particular radius. Radii on inner contours run up to 37/32nds in 32nd increments. Sizes and radius points are printed on the negative side to prevent wearing off.

A new mortar sealant has been specially formulated for use on glass block. Known as "Klee Sealant for Mortar Between Glass Block," the material is used to coat the exterior mortar joints and is said to adhere to the mortar and form a tight flexible bond to the glass, expanding and contracting with the mortar as well as the glass without rupturing the film. The material is available in limited quantities from American Fluresit Co., 635 Rockdale Ave., Cincinnati, Ohio.

Sully Engineering, Ltd., 7416 Melrose Ave., Los Angeles, Calif., has developed the "Crown" torch, a self contained unit measuring 12 in. in length and 2¼ in. in diameter and weighing 2½ lb. It is designed to burn propane or butane gas, at 3800 F, and to operate for 8 hr before refilling is necessary. Its many uses are said to include the sealing of sweat joints, lead burning, light brazing, thawing frozen pipes, paint burning, soldering of copper pipe, and heating and bending. According to the manufacturer, the torch can be filled from any standard butane or propane tank.

Recently acquired by Leavitt Machine Co., Orange, Mass, as an addition to its regular line, the Swendeman steam trap has capacities up to 24,000 lb of water. Operating on the float valve principle, it is designed to discharge in a continuous and uninterrupted stream all water and air which it collects. The traps are available in seven sizes through the company's national distribution organization.

JOHN ZINK



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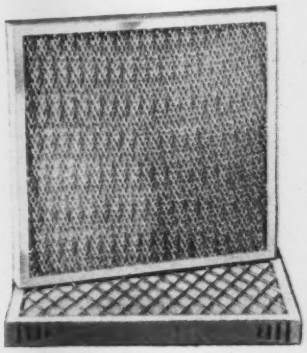

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A permanent, cleanable viscous type filter of all galvanized construction, having full bronze welded corners. Expanded metal face plate acts as lint arrestor to provide easier cleaning and servicing. Rated filtering efficiency 98.5%. In standard 1" and 2" thickness.

Also available for heavy duty service on industrial and special applications—in 2" to 4" thickness. Holding frames (for V-type or straight banks) are made for all type filters.

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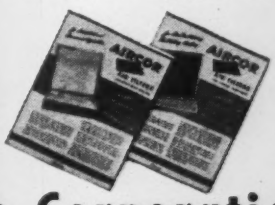

Air Filter Corporation

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TIME

PROVES

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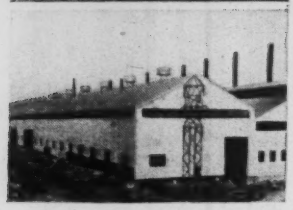
34 YEARS . . . Erected in 1913, and covered with heavy gauge galvanized sheets, this Tennessee concentrating plant of the A/Z Company, pictured at left, is still in excellent condition after more than three decades of service. Painted with Gray Metallic Zinc Paint in 1932.

50 YEARS . . . The galvanized metal roof on this old Missouri farm building has outlasted the building itself, and is still in good condition after half a century of service. Industry and the farm have long depended on galvanizing to protect iron and steel against costly rust. Builders know that as long as iron or steel is zinc covered, it *cannot rust.*



In building for the future, look to the past for proof of a building material's strength . . . durability . . . service. With *galvanized* (zinc-coated) roofing and siding you get the strength of steel . . . the rust protection of Zinc. So for low-cost, long-time service choose the building material that's proved by TIME itself . . . galvanized sheets. Send coupon for information about Zinc and how it helps keep buildings and equipment *stronger longer.*

ZINC INSTITUTE 2 OZ. COATING SEAL OF QUALITY

This "Seal of Quality" is your guide to economy in buying galvanized sheets. Sheets bearing it carry at least 2 oz. Zinc per sq. ft.

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- ☐ Facts about Galvanized Sheets
- ☐ Use of Metallic Zinc Paint to Protect Metal Surfaces

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EXECUTIVE CHANGES

Announcement has been made of the election of L. P. Hanson to the position of vice president in charge of sales for the United States Air Conditioning Corp., Minneapolis. He has been with the company for 19 years and is a graduate of the University of Minnesota. Other personnel changes include the appointment of Harold Goodman as assistant to the president and C. S. Kessler as manager of the service organization.

R. W. Christensen has been named assistant advertising manager, aluminum division, Reynolds Metals Co., Louisville, Ky., according to an announcement by D. F. Beard, advertising manager. He succeeds J. C. Bjorkholm who was recently advanced to advertising manager of the company's foil division. In his new position Mr. Christensen will also handle advertising for the company's railway and industrial machinery divisions.

At the last annual meeting of the directors of Baker Ice Machine Co., Inc., South Windham, Me., A. F. Milton was elected treasurer of the company. In addition to his new responsibilities, Mr. Milton will continue to act as chairman of the executive committee of the board of directors and secretary of the company. He is also a director of the subsidiary Northwest Baker Ice Machine Co., Inc., Seattle.

H. O. S. Bridcutt has been appointed director and executive vice president of Richard Crittall Radiant Heating, Inc., New York City. He recently arrived from England and is a director of Richard Crittall & Co., Ltd., London.

Last month, C. S. "Chet" Stackpole assumed his new duties as general sales manager for the Airtemp Div., Chrysler Corp., Dayton, Ohio. He brings a broad background of experience in the sales and merchandising field to his new position and is currently vice president and chairman of the residential section of the American Gas Association, vice president of the Sales Executive Council of Baltimore, a member of the American Society of Refrigerating Engineers, and a member of the sales personnel committee of the Edison Electric Institute.

Eutectic Welding Alloys Corp., New York City, manufacturer and distributor of special gas and arc welding rods, fluxes, and welding equipment, has appointed T. I. Leston as vice president in charge of production. A graduate of Arnstadt Polytechnic Institute in chemical engineering, Mr. Leston completed his metallurgical training at Faculte des Sciences, Paris, and New York University. He was assigned to company projects in the research laboratories at the beginning of 1944, and thereafter, he guided several new arc welding electrodes and alloys through the pilot-plant stages to full production.

Here it is!

A STURDY *Hand-size* SHUT-OFF VALVE FOR *Giant-size* CONTROL JOBS

There's nothing flimsy about this trim little ASCO Two-Way Solenoid Valve. Extra heavy, forged brass body standard, or special alloy body and trim for corrosive conditions . . . stainless steel renewable seats and disc . . . conduit connection box integral with solenoid housing . . . continuous duty coils . . . capable of opening and closing at frequencies of 400 times per minute.

No, there's nothing flimsy about this ASCO Two-Way Shut-off Valve. Nor is it particularly fussy about what it handles, being designed for air, water, gas, refrigerants, light oils, and many chemicals.

Send for descriptive literature so that you can study the merits of this ASCO Valve in relation to your automatic shut-off valve requirements.

Circular 200 describes briefly many of the other ASCO Solenoid Valves. Send for a copy for future reference. Also, if interested in switches, send for Circular 600 describing our line of Automatic Transfer Switches, Remote Control Switches, Contactors, Relays.

IMMEDIATE DELIVERY
3/8" Pipe Size

ASCO VALVES

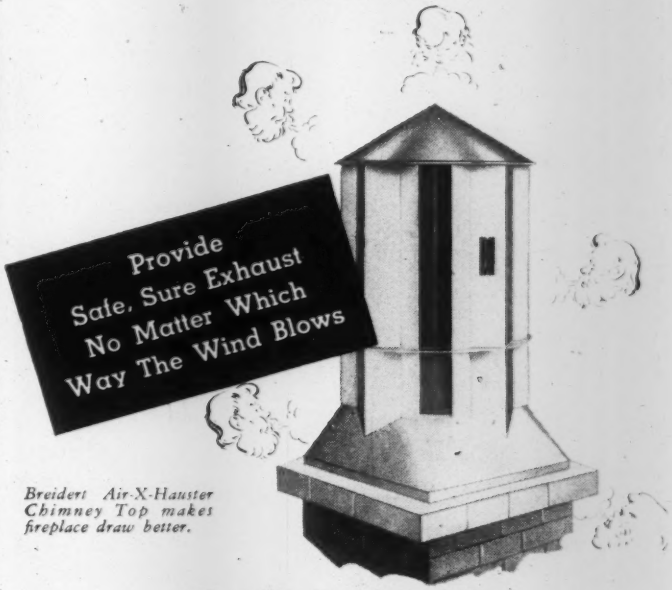
Automatic Switch Co.

389 Lakeside Avenue, Orange, New Jersey

ON CHIMNEYS AND VENT FLUES

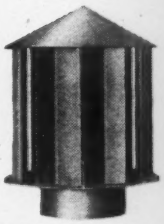
Breidert Air-X-Hausters

(PAT. NO. 2269428)



Breidert Air-X-Hauster Chimney Top makes fireplace draw better.

the first scientific improvement in roof ventilators in over 50 years!



Type B Breidert Air-X-Hauster for factories, commercial and residential buildings.

No matter which way the wind blows, no matter how bad the weather—the Breidert *provides positive exhaust*. Designed in accordance with the science of aerodynamics, this revolutionary ventilator utilizes the power of air currents coming from *all angles* to provide safe, positive ventilation without back-draft. Stationary—no moving parts to regulate or get out of order . . . no power consumption . . . compact and pleasing in appearance.

Breidert Air-X-Hauster—the first ventilator to be tested under all variable vertical and horizontal wind conditions . . . with certified ratings published.

Unlike most conventional ventilators which work efficiently only when wind strikes in a horizontal plane, the Breidert has been thoroughly tested—by U. S. Navy and Smith Emery Commercial Testing Laboratories—with the wind blowing in *all* directions. Its remarkably high performance ratings under all conditions are *certified and published*.

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Breidert Air-X-Hausters have found wide acceptance among architects, engineers, industrialists, farmers, home owners, ship and boat owners. U. S. Army, U. S. Navy, Maritime Commission, schools, institutions and public buildings. In every case when properly installed, the Breidert has never failed to fully meet every claim made for it!

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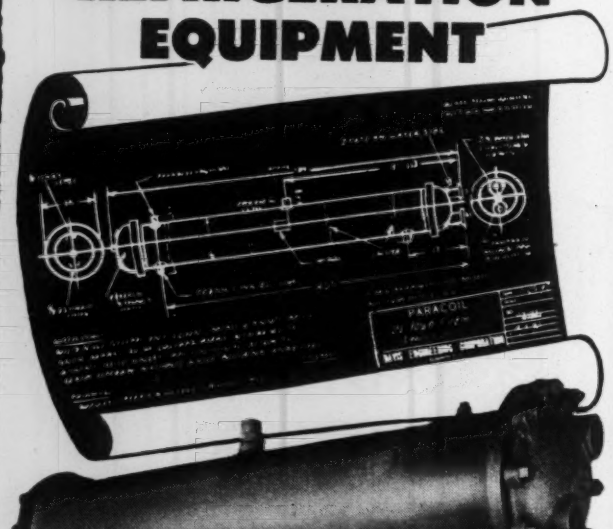

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Steel Shell — C. I. Chamber
Finned Copper Tubes
A Typical PARACOIL Product

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Finned or Bare Tubes
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Designed to Any Stationary or Marine Code

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30 Rockefeller Plaza, New York 20, N. Y.

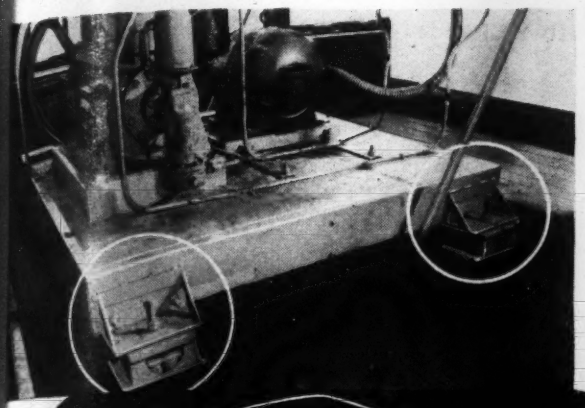
Executive Changes (Cont.)

The appointment of four vice presidents has been announced by H. P. Etter, president, Air Reduction Pacific Co., Mills Tower, San Francisco, the new subsidiary of Air Reduction Co., Inc., recently organized to take over the west coast business of Air Reduction Sales Co. The new vice presidents and their respective districts are: L. A. Hamilton, Seattle; E. W. MacCorkle, Jr., Portland; H. W. Saunders, San Francisco; and H. A. Hoth, Los Angeles. The west coast company produces and sells oxygen, acetylene, and the necessary apparatus for the oxyacetylene cutting and welding processes. It also distributes arc welding machines and related equipment. Prior to the formation of the new company, the west coast business of Air Reduction Sales Co. was conducted through local district offices, and the company's headquarters was in New York.

M. J. Graham has been named manager of the West Leechburg, Pa. plant of Allegheny Ludlum Steel Corp., Pittsburgh. F. G. Benford will serve as assistant plant manager. Mr. Graham joined the company in 1933 after being graduated from Lehigh University. After eight years in the service departments of the Brackenridge, Pa. and West Leechburg plants he was named production manager of the defense plant operated by the company during the war at Dunkirk, N. Y. Upon his discharge from the Navy in 1946, he was made assistant manager of the West Leechburg plant and was named acting plant manager last year. Mr. Benford was graduated from Penn State as a metallurgical engineer in 1933 and joined the company as chief metallurgist of the West Leechburg plant in 1945.

The name of the Vermiculite Research Institute, Evanston, Ill., has been changed to the Vermiculite Institute, and E. R. Murphy succeeds V. E. Watts as managing director and executive secretary. As the change in the name implies, the institute will no longer be primarily concerned with research. Its functions will be promotion of the use of vermiculite products nationally, cooperation with allied industries in the construction field, and the preparation of new literature and publicity. Mr. Murphy was assistant chief engineer of the Gypsum Association for over 12 years, and prior to that time, he was with the structural clay products industry code authority during NRA, and with the former Metal Lath Manufacturers Association. Research into the properties and possibilities of vermiculite will be continued by Mr. Watts who is opening his own research laboratory in Palo Alto, Calif. While he will specialize in product development and improvement for other industries, a large portion of his time will be spent on vermiculite.

The appointment of R. B. Cherry, Jr. as southeastern regional sales director of Typhoon Air Conditioning Co., Inc., Brooklyn, N. Y., has recently been announced. He will supervise the company's representation in the states of Florida, Georgia, Louisiana, Mississippi, and South Carolina, making his headquarters in Atlanta, Ga.



Third Floor Installation MADE PRACTICAL ...by KORFUND

Locating air conditioning equipment anywhere above the ground floor presents problems, mainly because of excessive vibration and noise in operation. Korfund Standard Vibro-Isolator Units have solved this problem many times.

For example, Valley Weathermakers, Harlingen, Texas, recently installed a reciprocating compressor on the third floor of S. H. Kress & Co. building, Brownsville, Texas. In this instance, installation was made even more difficult by location near the offices and sales floor. Yet today the 2300 lb. compressor and 900 lb., 40 HP motor are operating satisfactorily mounted on four Korfund LK/F Vibro-Isolators. Valley Weathermakers' letter states:

"... These isolators are doing an excellent job of removing vibration caused by the motor and compressor. You can stand in the office directly below the equipment and not be able to tell whether or not (it) is in operation ... The Construction Superintendent for S. H. Kress & Co. ... was very much pleased ... (In another case) we have an air conditioning compressor installed on the second floor of an office building, and it is disturbing the tenants below. From the results of the Brownsville, Texas, job, we feel sure that your Isolators will remedy the trouble on this installation."

It is interesting to note that more than 75% of Korfund orders in the air conditioning field are *repeat* business. We'll be glad to send further details showing why this is so. Write us today about your problems in Vibration Control.

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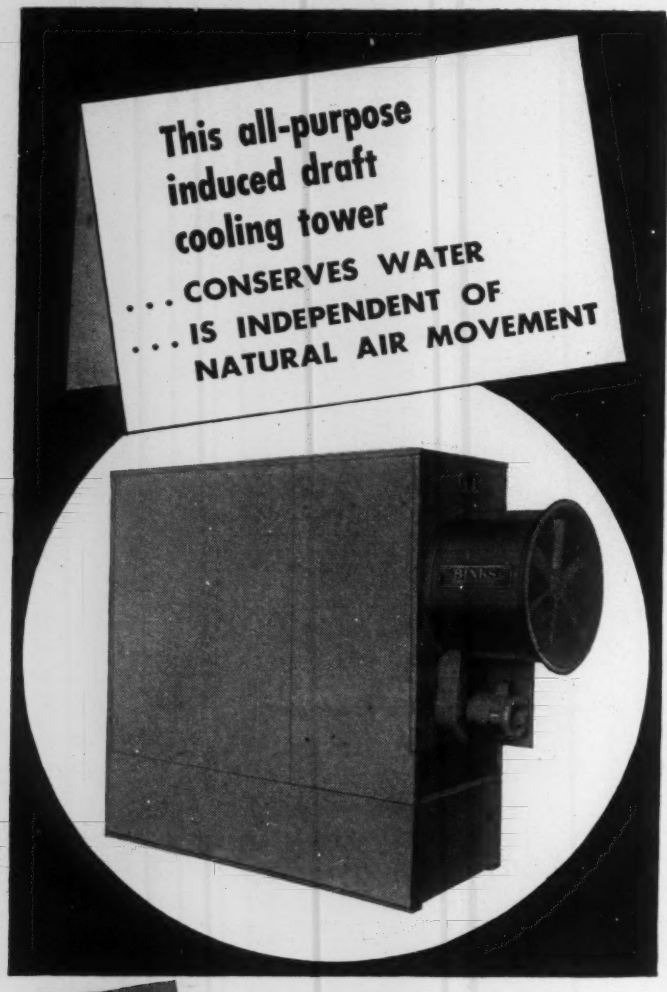

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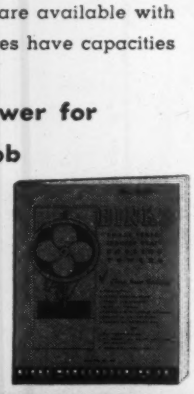


Binks MANUFACTURING COMPANY
3114-40 CARROLL AVE., CHICAGO 12, ILL.
OFFICES IN ALL PRINCIPAL CITIES

Executive Changes (Cont.)

McDonnell & Miller, Inc., Chicago, has announced the appointment of Nils Swanson as a vice president of the corporation. He is widely known in the heating industry through his long association with the company's boiler water feeders, low water cutoffs and safety relief valves.

E. B. Maire is the newly named sales manager of eight midwestern, southern, and eastern branch offices of General Controls Co., Glendale, Calif. He will be in charge of the Boston, Philadelphia, Pittsburgh, Birmingham, New York, Detroit, Cleveland, and Chicago offices, and will assist and coordinate the efforts of these branches in the sale of automatic temperature, pressure, and flow controls.

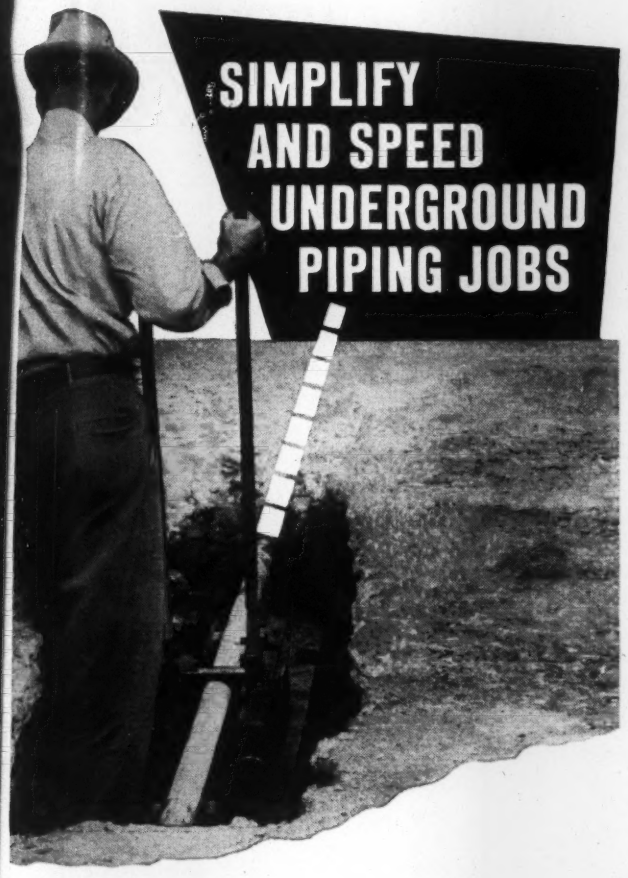
Mitchel Landau has joined York-Shipley, Inc., York, Pa., as assistant to the president, in charge of merchandising. He is widely known as an author of magazine articles on heating and air conditioning. As assistant to the president, he will be in full charge of the development of a merchandising program including residential and industrial oil fired heating equipment.

C. C. Tippit has been named manager of the newly created order and planning department, Reliance Electric & Engineering Co., Cleveland. Mr. Tippit graduated from Williams College and took additional training at Massachusetts Institute of Technology as a meteorologist in the Army Air Corps. He subsequently served in the European theater for two years before joining the company in September 1945.

Continuing the expansion program which was set up a few months ago, Refrigeration Engineering, Inc., Los Angeles, has announced the appointment of Albert Rebel as export manager of the company which is offering a line of unit coolers, evaporative condensers, floor units, and air conditioning equipment under the trade name of "Recold." Mr. Rebel has been active in the export field of the commercial refrigeration industry.

O. P. Bereit, for the past year comptroller of the Parker Appliance Co., Cleveland, maker of aircraft and industrial valves and fittings, has been elected treasurer and comptroller, according to a recent announcement by S. B. Taylor, company president. Mr. Bereit received his schooling at Case Institute of Technology and Cleveland Law School, graduating from the latter in 1929.

Announcement of the appointment of F. M. Mason to the position of vice president in charge of its Atlantic plant has been made by U. S. Electrical Motors, Inc. Mr. Mason, who will have his headquarters at the company's Milford plant, started at the bottom of the ladder in the test department in 1930, and since then has risen rapidly through various departments.



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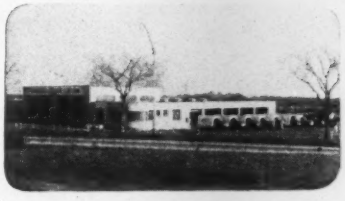
Old Plant of Costa's Ice Cream Company

Today Frick Equipment carries the entire cooling load at the Company's magnificent new plant, one of the finest in existence, adjoining U. S. Highway No. 1 at Woodbridge, New Jersey.



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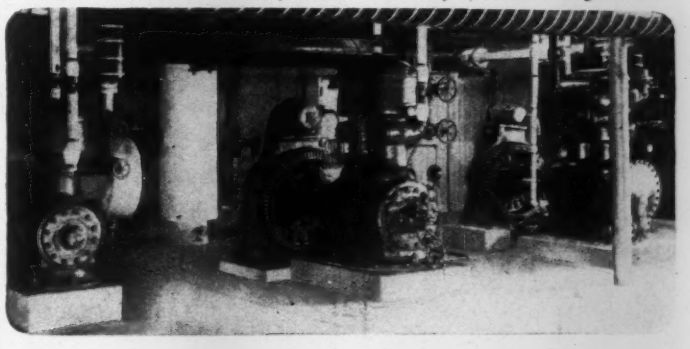

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For your convenience in obtaining copies of these bulletins, see coupon on page 181. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.

Air Recovery Equipment

No. 6810—W. B. Connor Engineering Corp., 114 E. 32nd St., New York 16, N. Y., has issued a new 16 page booklet (No. 105-A) on its type H "Dorex" air recovery equipment used in the "recovery" or conversion of stale, vitiated air by adsorption of gases and vapors. Activated carbon, the adsorption agent, is used in hollow wall cylindrical canisters which are available in a variety of arrangements for duct installations, etc. Typical assembly arrangements, dimensions, framing details, and capacity and resistance curves are included.

Aluminum Sheet and Plate

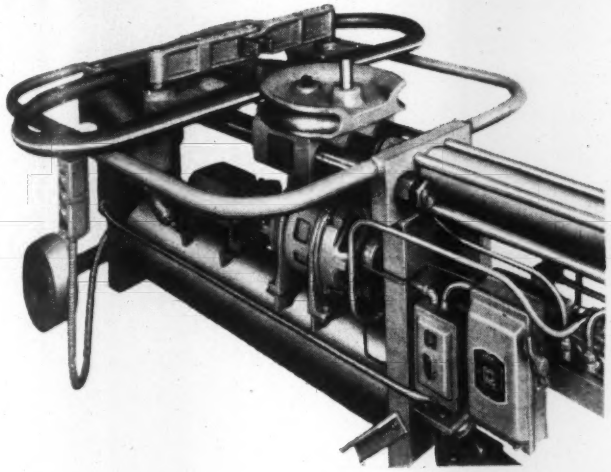
No. 6811—A 48 page, 6 x 9 in. booklet, Aluminum Sheet and Plate, has been released by Reynolds Metals Co., Aluminum Div., Desk 105, 2500 S. Third St., Louisville 1, Ky. According to the manufacturer, the booklet is designed to meet the needs of the experienced aluminum user as well as the newcomer. Information relative to various sheet and plate alloys, gages, and sizes, is included, along with a brief discussion of cost factors which provide data for a comparative analysis of the cost of aluminum sheet and plate as against other widely used metals.

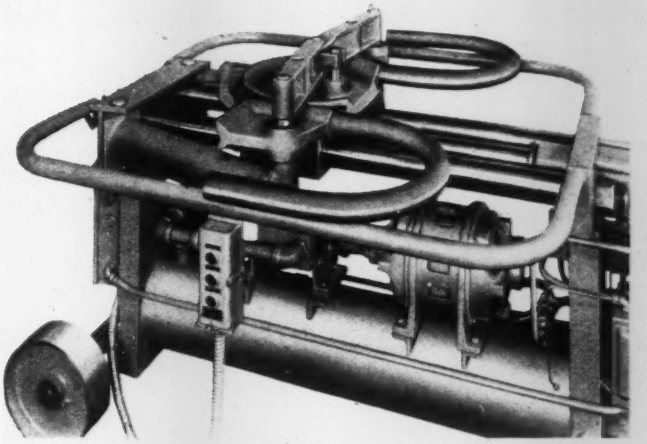
Also given are summaries of such topics as forming, welding, riveting, brazing, and soldering, together with resistance to chemical attack and heat treatable and non-heat-treatable alloys. Finishes for sheet and plate, characteristics of the metal, and the avoidance of distortion are likewise summarized. Since aluminum sheet and plate are sold by weight, a rather large section of the booklet contains tables for computing the weight of various sizes and thicknesses of sheet and plate items. One of the final sections of the booklet gives an index of specifications as listed by various government bureaus and a number of leading professional societies. Some of the tabulated data are used to present information on chemical compositions, mechanical properties, commercial tolerances, and bend radii.

Automatic Damper Control for Regulating Draft

No. 6812—An electric damper control with automatic time delay features and for controlling the draft on commercial and industrial boilers is covered in a four page bulletin released by Cleveland Fuel Equipment Co., 1836 Euclid Ave., Cleveland 15, Ohio. In addition to a discussion of how the control functions, installation instructions, wiring diagrams, and general specifications are included.

IDEAL FOR RADIANT HEAT PIPE BENDING





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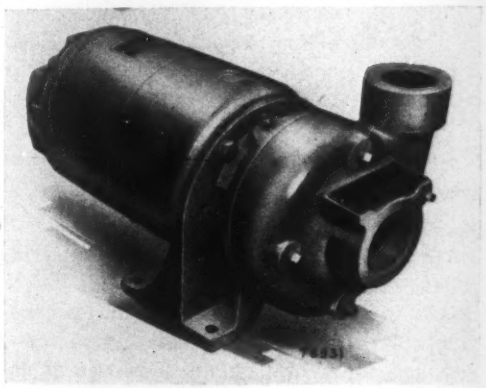

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Cold Process Water Conditioner

No. 6813—Publication 4425 is being distributed by Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia 32, Pa. It describes the company's recently announced "Rapid Reactor" which is designed to combine cold process water softening with the basic elements for mixing, floc formation, settling, and thickening in a single reaction vessel. The unit is said to be finding widespread application in industry for the conditioning of process cooling water and boiler feed. Chemical reagents may be introduced for coagulation of turbidity alone, for partial softening with coincident turbidity reduction, or for complete softening and turbidity reduction. The publication contains detailed explanations of the process and the operation of the equipment.

Combination Starter for Induction and Synchronous Motors

No. 6814—Publication 3100 PRD-192, issued by the Electric Machinery Mfg. Co., Minneapolis 13, Minn., shows the construction, operation, and application of the "Hi-Fuse" combination starter for high voltage induction and synchronous motors for industry. A featured discussion describes how the high interrupting capacity fuses provide short circuit protection.

Disc or Butterfly Type Valves

No. 6815—The butterfly or disc type valves offered by R-S Products Corp., Dept. DH, Wayne Junction, Philadelphia 44, Pa., are described and illustrated in a new catalog (No. 17) just released. The 52 page booklet shows 11 basic types of valves, including detailed elevations showing manual controls, extended shafts for automatic controls, and finned boxes for high temperature service.

Electric Contact Controller

No. 6816—Bulletin 98098 describes the new electric contact controller (indicating or recording) offered by Taylor Instrument Companies, P. O. Box 110, Rochester 1, N. Y. Photographs, together with construction and application drawings, show how this unit is used for on-off applications involving temperature, pressure, flow, liquid level, and humidity.

Electric Controls, Meters, and Instruments

No. 6817—A 66 page illustrated catalog, which is said to be a veritable handbook because of its comprehensive coverage, describes the standard makes of instruments and controls offered by Electro-Tech Equipment Co., 117 Lafayette St., New York 13, N. Y. In addition to its illustrations, the catalog gives complete data, specifications, and prices. One page is devoted to suggestions on the purchase and use of instruments. Also included are data, tables, and connection diagrams on rectifiers, variable voltage transformers, and the like. Various sections of the book cover pyrometers, pyrometric controllers, recorders, and thermocouples, together with portable, panel, and switchboard meters. Other products

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THE ANSWER TO 2 MAJOR AIR CONDITIONING PROBLEMS

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Here is the ideal automatic air conditioning unit for any building located where power facilities are not adequate or where 3-phase commercial power is not available. The unit consists of a modern, radial compressor that is driven by a direct-connected International industrial-type engine. Ready-Power Engined Refrigeration Units are designed and built to give highest quality air conditioning.

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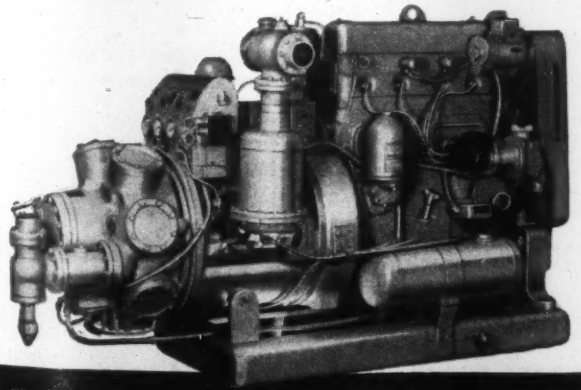

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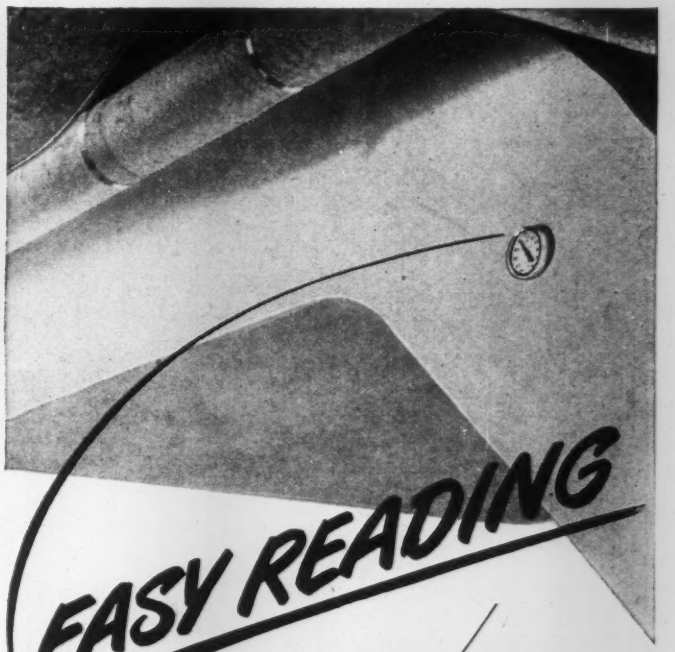

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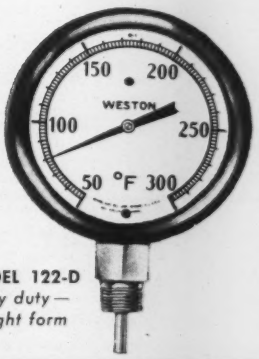

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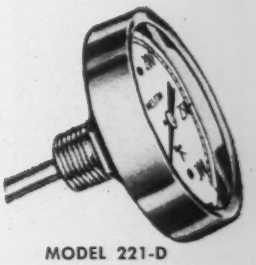

MODEL 221-D
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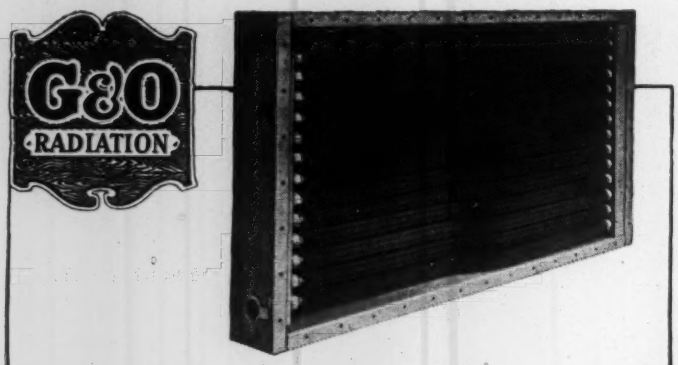

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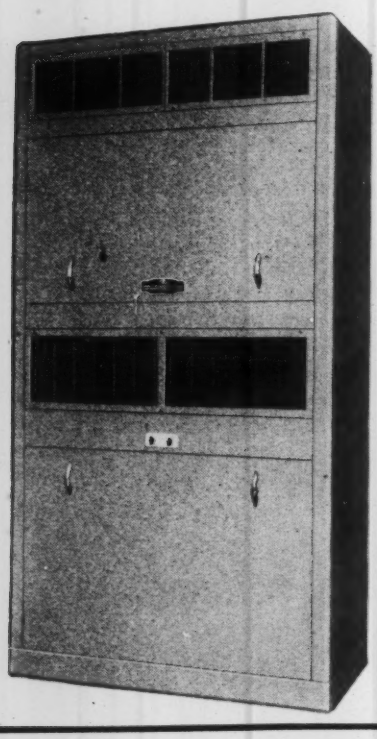
Electronic Interval Timer

No. 6818—An electronic timer, series 30, designed for machinery and process control and having a range from 0.03 sec to 4 min, is described in bulletin PC478 issued by Photoswitch Inc., 77 Broadway, Cambridge 42, Mass. The unit is recommended by the manufacturer for the control of hydraulic presses, chemical feeders, spot welders, grinders, drilling machines, and similar equipment. It may be wired to provide interval timing, delayed action, automatic repeat, and programming, as well as many variations of these.

Flexible Couplings

No. 6819—A new booklet, entitled Relief from Bearing Wear Grief, describes how a number of plants are preventing bearing failures, shaft failure, and damaged equipment because of the improper coupling of rotating shafts. The booklet describes the functions of flexible couplings and gives an explanation and analysis of the principles by which they operate. In addition, descriptive material and illustrations are used to show how the operation of the company's flexible coupling compensates for end thrust and the three types of shaft misalignment. A section of the booklet describes the maintenance of this coupling. This 24 page booklet is available from the manufacturer, American Flexible Coupling Co., 1801 Pittsburgh Ave., Erie, Pa.



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• 3-ton Model 3NAC and the 5-ton Model 5NAC GR Unit Air Conditioners provide year around air filtration and ventilation, also summer cooling and dehumidifying. A heating coil may be added if desired.

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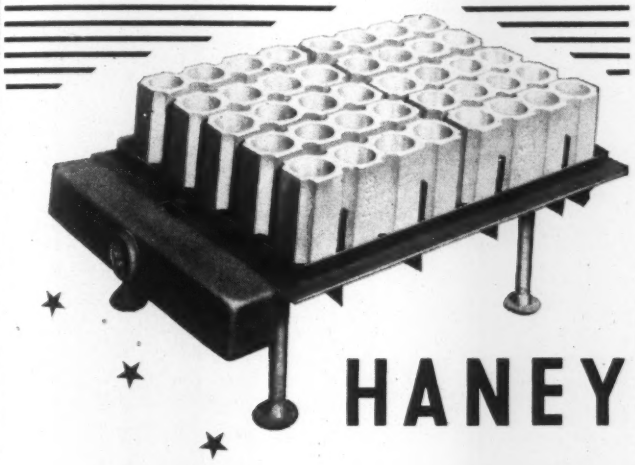
Forced Hot Water Heating Systems

No. 6820—Capture the Sun with "Hydro-Flo" Heating is the title of a new 17 page consumer booklet on the application of forced hot water heating equipment to radiator, convector, baseboard, and radiant panel systems. Issued by Bell & Gossett Co., Morton Grove, Ill., the booklet stresses the use of the company's heating specialties in all forms of radiant heating. The advantages of zoning larger systems from the standpoint of fuel economy and comfort are pointed out.

Fuel Oil Supply

No. 6821—Stating that "it has been virtually impossible for the public to sift the conflicting hopes, suppositions, facts, and figures and acquire a considered opinion of its own on fuel oil supply," the Oil-Heat Institute of America, Inc., 6 E. 39th St., New York 16, N. Y., has published an information booklet, Answers—Your Questions About Burning Oils. Quoting from industry and government sources the booklet, in question and answer form, provides information on supply factors from crude reserves through the delivery of the refined product. The booklet will be distributed to the oil burning public by members of OHI and all others in the industry. Copies will be furnished in lots of more than 100 at cost (2½ to 3½ cents each depending on the quantity ordered) to anyone who desires copies for distribution to the public. A sample booklet and order form can be secured from OHI headquarters.



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We'll be glad to send more information on request . . . please write!

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STEP UP your circulation with AUTO-VENT Air Eliminators

HERE'S HOW TO VENT!

- Hot Water Heating Lines
- Hot Water— Convectors Unit Heaters Baseboards
- Cold Water Lines
- Coils, Tanks, Etc.

Simple as A-B-C . . . yet positive in action every time! Sure-cure for air pockets and air traps that hold up the free circulation of water or other liquids flowing through pipes —pressures to 75 lbs. Simple in construction—easy to install!

Built of brass with self-closing float operated valve. Withstands high temperatures, oil and other adverse conditions. **Try these No. 7 Auto-Vents once, and you'll use them on every job. They're that good, yet NOT expensive!**

★ ★ ★

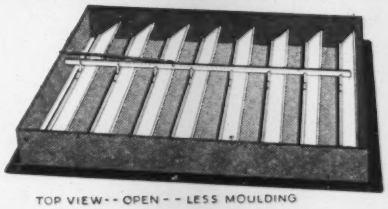
IT WILL PAY for you to have information and prices on the complete Maid-O'-Mist line which includes other types of air eliminators, and heating specialties Write us today, or see your jobber!

MAID-O'-MIST INC.

3215 N. PULASKI RD.
CHICAGO 41, ILLINOIS

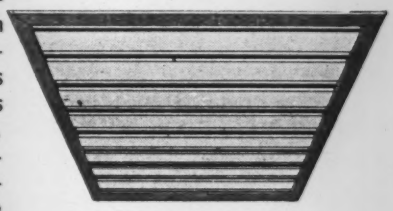
AUTOMATIC HUMIDIFIERS FOR ALL TYPES OF HEATING SYSTEMS

AIR-FLO AUTOMATIC CEILING SHUTTER FOR ATTIC FANS



TOP VIEW - - OPEN - - LESS MOULDING

Built so they can be installed practically flush with the ceiling, AIR-FLO Ceiling Shutters present a refined, finished appearance. Their natural aluminum color blends with any decoration, eliminating need for painting, and no grille or winter cover is required. Furnished in 5 different widths, single panel up to 73" long. No operating mechanism shows. Built-in fusible link. Meets fire underwriters requirements. Write for illustrated catalog 42-D of the complete AIR-FLO line.



VIEW FROM BELOW - - CLOSED (with moulding)

AIR CONDITIONING PRODUCTS CO.

2340 W. Lafayette .Blvd., Detroit 16, Mich.

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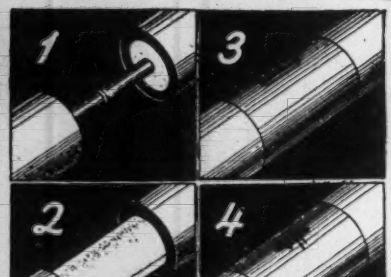
Positive Protection



4 Simple Steps

1. Field joint ready for inspection. 2. Joint covered with standard pipe insulation. 3. Durant joint casing in place ready for asphalt. 4. Asphalt poured in slot making a perfect seal.

BUILT-IN at FACTORY

For all your underground and exposed piping jobs you'll like DURANT Pre-Sealed Insulated Pipe. It is waterproof . . . reduces installation costs to a minimum . . . eliminates electrolysis and corrosion . . . requires very little trenching and field work . . . avoids extra cost of waste and breakage . . . comes to you ready to install. In short, D.I.P. is the *perfect pipe* for this type of job. Investgate D.I.P.! Write for details today.

Ready to Install

PRE SEALED

FOR STEAM HOT WATER REFRIGERATION

Trade Mark

Reg. U.S Pat. Off

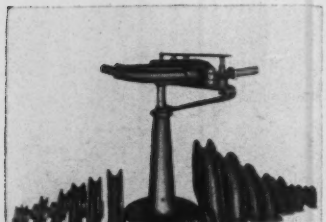
D.I.P.

Durant
INSULATED PIPE CO.
1015 Runnymede St.
Palo Alto, Calif.

The ORIGINAL Pre-sealed Insulated Pipe

Use "American"
PIPE BENDING MACHINES . . .
for fast, dependable bends

Radiant HEAT Pipe Bending is simple, accurate with good equipment . . . hand or motor-powered machines available . . . up to 8" capacities.



The Hand-powered "American" A-30

Bends ½" to 2" standard pipe sizes to a radius of 5 to 1, up to 180°. Special radii within these sizes supplied on request. Usual radiant heat bends for 1¼" at 6" & 9" radii can be supplied. Special radius supplied on request.

- Average bend takes only 60 seconds!
- Versatile—bends cold pipe, conduit and tube, copper and brass I.P.S. without crimping.
- 12,000 in use all over the world.

BENT ONCE — BENT RIGHT
ON "AMERICAN" PIPE BENDING MACHINES

American
PIPE BENDING MACHINE Company INC.

Factory and Main Office: 17 Furnace St., Poultney, Vermont

Heavy Fuel Oil Burners

No. 6822—A four color brochure (Form A-60[illegible]) illustrates and describes the fully automatic heavy oil burner offered by Ray Oil Burner Co., 401-499 Bernal Ave., San Francisco 12, Calif. Design and construction features as well as the path of fuel through the burner are illustrated.

Industrial Adhesives

No. 6823—Minnesota Mining & Mfg. Co., 901 Fauquier Ave., St. Paul 6, Minn., has issued a 27 page brochure on its adhesives, sealers, and coatings. The booklet contains 40 illustrations, cites 18 case histories, and lists 26 of the more than 1000 formulas offered. Pictured are bonding operations such as plywood-to-metal and vinyl-sheeting-to-wood, sealing operations, and protective and anti-corrosion coatings for metal.

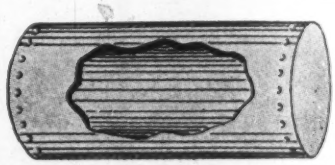
Malleable Pipe Fittings for Brazed Joints

No. 6824—Malleable pipe fittings which are said to be the first threadless malleable fittings made for brazed pipe joints are described and illustrated in a 16 page bulletin released by Stanley G. Flagg & Co., Inc., 1421 Chestnut St., Philadelphia 2, Pa. Available sizes, prices, and dimensions of a variety of elbows, tees, couplings, unions, and reducing tees are given and numerous applications are described.

Packaged Boilers for Process Steam

No. 6825—"Hot Steam" packaged boilers, built by Alert Engineering Products Co., 315 W. Woodbridge St., De-

NEW LIFE!



to Old Water Tanks
WITH APEX PERMANENT PORCELAIN LINING. Pitted or leaky water tanks can be restored to original usefulness by relining, applied in two coats approximately ¼" thick—cures under water—has an affinity for lime—prevents corrosive and pitting action on metal—withstands temperatures up to 250° without cracking—adds years to life of tank.

RIDAL SERVICE CLEANS
CHEMICALLY STEAM & WATER SYSTEMS. Eliminate sludge and foreign matter from your entire plant safely and economically. We clean and restore to original operating efficiency CHEMICALLY such equipment as: TURBINES — CONDENSERS — STEAM FEED LINES — CONDENSATE RETURNS —WATER HEATERS—STEAM KETTLES—COOLING AND HEATING COILS — PREHEATERS — HEAT EXCHANGERS — EVAPORATORS — TRAPS OF ALL KINDS — ETC.

Consultation Service—Without Obligation

APEX Engineering Company
Central 2909
75 E. WACKER DRIVE CHICAGO, ILL.

troit 26, Mich., are designed for producing process steam and are available in sizes from 2 to 50 hp. They are briefly described in Bulletin 148. According to the manufacturer, these automatic units, which are built in accordance with the ASME Boiler Construction Code, are suitable for pressures up to 100 psi, or higher if desired, and may be fired by either gas or oil. Design and construction features are outlined and numerous applications are listed.

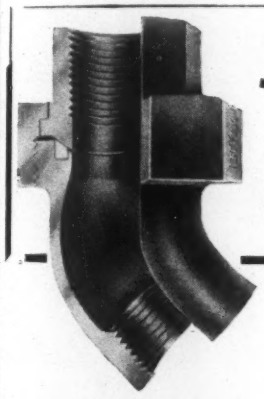
Photoelectric Combustion Safeguard

No. 6826—Combustion Control Corp., 77 Broadway, Cambridge 42, Mass., has recently introduced its new photoelectric scanner type 45PH5 for flame failure protection of oil burners. This is used in combination with the company's control type 24QJ5 to provide operating protection of the oil burner installation and may also be used with the programmer type 24PJ8 if starting protection and automatic ignition are required as well. This equipment is described in bulletin FF-1.

Pressure-Temperature Relationships of Refrigerants

No. 6827—Two new 8½ x 11 in. charts covering the pressure-temperature relationships of 24 different refrigerants have been compiled by Kinetic Chemicals, Inc., Wilmington 98, Del. According to the company, there has been a wide demand for suitable charts or curves which would cover not only the eight "Freon"

BETTER
Flexible
METAL HOSE
FOR EVERY PURPOSE
• SEAMLESS—Constructed from one continuous piece of uniform thickness • PARALLEL CORRUGATION assures maximum strength and flexibility • SPECIAL ALLOYS provide resistance to heat, acid, etc., depending on requirements • AVAILABLE in wide variety of types to convey all kinds of liquids and gases • AVAILABLE in complete form as vibration reducers for Air Conditioning and Refrigeration Units.
White Eclipse-Pioneer for information.
ECLIPSE-PIONEER Division of
TETERBORO, NEW JERSEY
Bendix
AVIATION CORPORATION



JEFFERSON
SPECIALTY
UNIONS

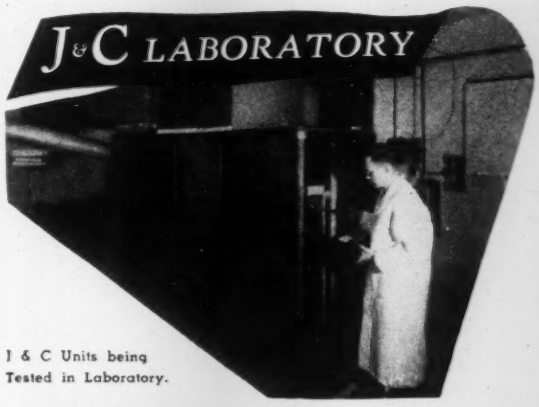
SIMPLIFY PIPING MAINTENANCE • EFFECT SAVINGS IN LABOR

TYPICAL of the complete Jefferson line is the 45 degree union ell illustrated. It helps you to simplify piping maintenance because the exclusive brass seating feature assures tight, lasting joints, guarding against leaks and effecting savings in labor because there are fewer joints involved wherever unions are used. The brass seat is cut from seamless drawn tubing, free from all casting defects. It can't be unseated regardless of how far pipe ends are screwed in. Jefferson Unions offer many other benefits which we will he happy to advise if you'll just drop us a line.

JEFFERSON UNION CO.

601 West 26th Street, New York 1, N. Y.

Lexington 73, Mass. Lockport, N. Y.



J & C Units being Tested in Laboratory.

PROVES PERFORMANCE

PRECISE MEASUREMENT . . . Of exact static pressure drop across each J & C unit and proper blower size for each J & C Model.

EXHAUSTIVE TESTS . . . of J & C units provide installation engineers with the data needed for correct installations.

ONLY IN THE LABORATORY . . . may technicians definitely establish:

Correct Pressure Loss Measurements
Proper Temperature Rise
Accurate Flue Gas analysis
Known Heat Transfer

NO GUESSWORK . . . The J & C laboratory, working for you, permits accurate installations because performance capabilities are precisely determined.

THE COMPLETE LINE . . . . COMPLETELY PROVEN

J & C, America's largest and most complete Warm Air Heating Line, offers over 100 types and sizes with outputs from 3,800,000 down to 100,000 Btu in the Famous Tubular Series . . . other models down to 52,500 Btu. Exact engineering plus endless testing provide the J & C features that give you an "edge" when you specify or install J & C.

A PRODUCT OF
JACKSON & CHURCH COMPANY, SAGINAW, MICHIGAN

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TOUGH FLANGES FOR TOUGH JOBS

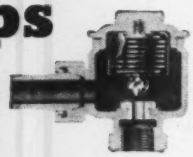
Drop forging makes Phoenix Flanges rugged . . . positions the grain flow of the metal so that maximum strength and ability to "take it" is the result. Available in a wide range of styles and sizes, all of mild steel especially suited to machining and welding. ASA requirements and ASME and ASTM specifications are met in every case. For details on these tough flanges for tough jobs, get your copy of the Phoenix Flange Catalog. Free on request.

PHOENIX MANUFACTURING COMPANY

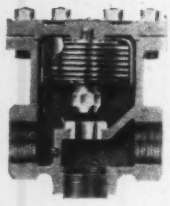
JOLIET, ILLINOIS △ CATASAUQUA, PA.

Nicholson Simplicity Enables You to

STOP Adjusting Steam Traps

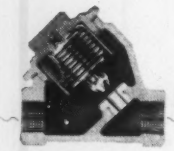


Nicholson traps require no adjustment or change of valve and seat from 0 to 225 lbs. This feature proves an exceptional trouble-saver in plants with many and varied trap applications. With these other 5 features, it accounts for the increasing standardization on Nicholson traps: 2 to 6 times average drainage capacity; operate on lowest temperature differential; no freeze-ups, air-binding, nor water-logging.



5 TYPES FOR EVERY PURPOSE.

power, heat, process; size ¼" to 2"; steam press. to 225 lbs. Also weight and piston-operated traps for steam, air, gasoline; press. to 1500 lbs. Expansion steam traps for press. to 225 lbs.



W. H. NICHOLSON & CO.

198 Oregon St., Wilkes-Barre, Pa.

Valves ★ Traps ★ Steam Specialties

Bulletin 1047 is a valuable reference on advanced drainage methods. Or see Sweet's.

refrigerants being currently produced, but also additional chemicals that are being used or have been used in the past as refrigerants.

Chart 1 covers the temperature range from —40 to 250 F and chart 2 covers the range from —180 to 60 F with the pressure ranges of both charts from 29.72 in. mercury vacuum (0.10 psia) to 985 psi gage (1000 psia). The charts were prepared to permit accurate and rapid temperature readings being made. Melting points, critical points, and triple points are also shown on these logarithmic charts.

Properties and Uses of Silicone Rubber

No. 6828—New and more complete data on all commercially available types of "Silastic", the silicone rubber offered by Dow Corning Corp., Midland, Mich., are given in a 16 page booklet, Silastic Facts No. 5. Several new types of products are covered as well as the six pastes and six molding and extruding stocks for which typical physical properties, including hardness, tensile strength, and elongation, are given. Some of the more important applications, such as in gasketing and electrical insulating material, are described.

Refrigeration Equipment

No. 6829—Catalog No. R-125, consisting of 32 pages and issued by Kramer Trenton Co., N. Olden & Bruening Aves., Trenton 5, N. J., covers the company's line of refrigeration equipment. Among the products described are a variety of unit coolers, the "Thermobank" hot gas

QUALITY always wins! **MARTOCELLO Products are fully DEPENDABLE**

ATOMIZING SPRAY NOZZLES, SPRAY POND NOZZLES, and CONDENSER WATER DISTRIBUTORS

For Vertical Shell and Tube Ammonia Condensers

ALL MARTOCELLO SPRAY NOZZLES are manufactured with precision and of a design which has been thoroughly tested for maximum results and durability. They are guaranteed to give satisfaction. Successful, efficient results depend largely upon selecting the proper number, type and size of Nozzles suitable for your installation.

THE MARTOCELLO CONDENSER WATER DISTRIBUTORS are now used as standard equipment by Progressive Refrigerating Engineers in solving their Manpower problem, because they require no attention and assure users of the lowest Condenser Operating Pressures and Minimum Power Cost.

It will pay you to consult us. WRITE or WIRE for further information.

Jos. A. Martocello & Co. 229-231 NORTH 13th STREET PHILADELPHIA 7, PA.

Serving the Ice Industry Since 1916 "There is no Substitute for MARTOCELLO QUALITY"

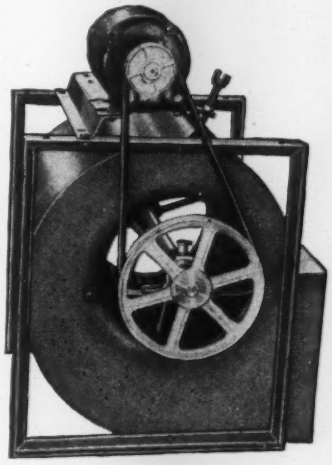
defrosting system, and a heat exchanger designed to provide heat transfer between the liquid refrigerant and the suction vapor for installations from ½ to 20 hp. Air cooled condensers for installations up to 3 hp and shell and fin tube condensers for installations up to 2 hp are also covered.

Refrigeration Valves

No. 6830—A new 20 page condensed catalog describing its entire line of refrigeration valves has been released by Automatic Products Co., 2450 N. 32nd St., Milwaukee 10, Wis. Thirty five photographs and drawings are used to illustrate design and construction features of the various units, including the new No. 304 automatic expansion valve, water and pressure regulating valves, check valves, solenoids, strainers, and filters. Specifications for each are included.

Registers and Grilles

No. 6831—The complete line of registers and grilles offered by Independent Register Co., 3747 E. 93rd St., Cleveland 5, Ohio, is described and illustrated in a new catalog (No. 48). Included in the 32 page booklet are "Fabrikated" cold air faces, floor registers, pipeless furnace gratings, air conditioning registers, and wall grilles, together with a wide variety of wrought steel registers and grilles. Sizes, list prices, and free areas are tabulated.



THE
NEW
UNIVERSAL
TYPE "N"
BLOWER

MASSACHUSETTS . .

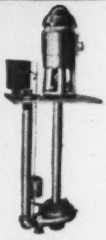
By changing the position of the oil cup, the four popular discharges (lower horizontal, upper horizontal, down-blast and up-blast) can be obtained. Sizes 7 to 16½ inches wheel diameter.

WRITE FOR BULLETIN No. 110 CATALOG

MASSACHUSETTS BLOWER DIVISION
The BISHOP & BABCOCK Mfg. Co.
4901 HAMILTON AVENUE · CLEVELAND 14, OHIO

INDUSTRY FAVOR is STEADILY MOUNTING for PUMPS "by Aurora"

Pump builders EXCLUSIVELY. What are your needs? We have a type and size for every pumping service. Get our recommendation—no obligation.



Aurora Deep Well Turbines for all conditions—4" to 24"

Type AD Hor. Split Case, Two Stage Centrifugal

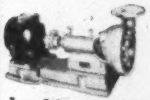
NSA Aurora Centrifugal Sump Pump

Type OD Hor. Split Case Double Suction Single Stage Centrifugal

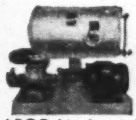
Type GMC Close-Coupled Centrifugal

Apco Turbine-Type Pumps
The simplest of all pumps. Ideal for small capacity, high head duties. Silent, compact and lasting.

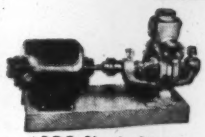
The ONLY MOVING PART in the APCO



Type GGU Side Suction Single Stage Centrifugal



APCO Horizontal Condensation Return Unit

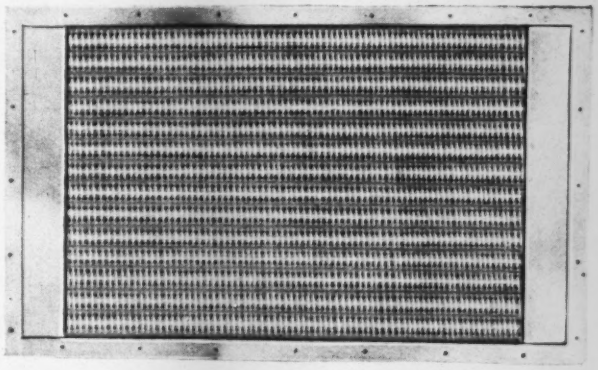


APCO Single Stage Turbine-Type

Write for CONDENSED CATALOG M or See Our Catalog in SWEETS.

DISTRIBUTORS IN PRINCIPAL CITIES

AURORA Always PUMPS
AURORA PUMP COMPANY
80 Loucks Street, AURORA, ILLINOIS



PERFECTION IN HEATING COILS

There's a best in everything and we know you'll agree that heating coils by Chicago Fan and Fin Coil Co. meet the most exacting requirements for dependable, efficient operation. We've been making them to the same high standards for over fifteen years—check over these features and see if they're not the answer to your needs:

- Efficient and stable at steam pressures up to 200 lbs.
- All expansion stresses are taken up in the heating section itself. No brazing or welding in assembly.
- Encased coils standard equipment ready for installation in any position or stacking arrangement. Widths 10" to 34". Tube lengths up to 120".
- Copper Tubes and Fin Gray Iron Cast Headers.
- All coils inspected for workmanship and tested hydrostatically to insure leak-proof operation.

IMMEDIATE DELIVERY—*Write for Bulletin 147*

CHICAGO FAN & FIN COIL CO.
1937 W. Walnut St. Chicago 12, Illinois

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WITH THE
BIG, QUIET FAN

In spring, winter and fall, working comfort is *automatically* maintained with Reznor gas fired heaters. Reznor thermostatic control is your non-salary fireman . . . you can forget expensive furnace firing with its family of operating and maintenance bothers.

Reznor heaters circulate live, warm air in abundance.

REZNOR
Gas fired unit heaters

SUSPENDED OR FLOOR MODEL

A SIZE FOR EVERY NEED

REZNOR CO. MERCER 8, PENNA.

GAS FIRED HEATERS SINCE 1888

NO BOILERS • NO STEAM LINES
NO FUEL STORAGE • NO FIRE TENDING

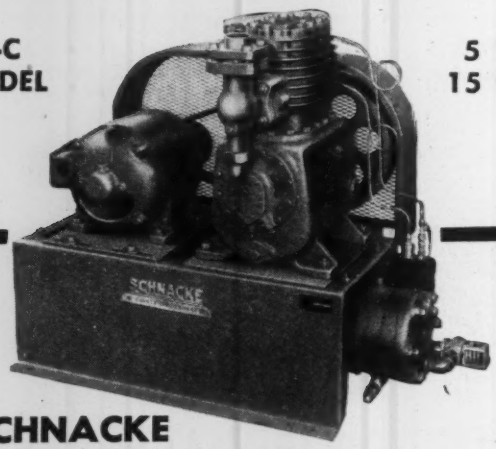
Slide and Butterfly Valves for Low Pressure Fluids

No. 6832—W. S. Rockwell Co., 200 Eliot St., Fairfield, Conn., has issued six new bulletins on its line of slide valves and butterfly valves which are designed for use with low pressure fluids, under 25 psi. The booklets provide information on applications, materials of construction, design and construction features, available sizes, and dimensions. Bulletin No. 500 covers the company's line of standard slide valves offered in sizes from 1 to 20 in. Bulletin No. 501 describes the "Kwikleen" slide valves for fluids and gases containing solids or for free flowing materials that tend to clog or jam conventional valves. Bulletins Nos. 502 and 503 are respectively devoted to flanged butterfly valves (in sizes from 4 to 48 in.) and "wafer thin" butterfly valves designed for pipe lines that allow little room for valve connections (in sizes from 4 to 72 in.). Threaded butterfly valves in pipe sizes from 1 to 4 in. are described and illustrated in Bulletin No. 504 and various automatic control mechanisms which can be applied to the company's valves are covered in Bulletin No. 505.

Stainless Steel Analyses

No. 6833—Globe Steel Tubes Co., 4010 W. Burnham St., Milwaukee 4, Wis., is offering, in its new booklet (No. 301), tabulated data showing the chemical analyses of most of the stainless steels produced and usually available. For more than seven years the company has periodically brought the chart up to date, and this

T-C MODEL



5 TO 15 H.P.

SCHNACKE
COMPLETE
CONDENSING UNITS
For Air Conditioning and Refrigeration

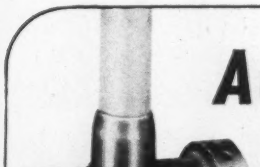
SCHNACKE Compressor has replaceable, refrigerant-cooled steel cylinder sleeves, balanced forged crankshaft, sealed crankcase, complete pressure lubrication, and many other advanced features.

Condenser is ASME approved, fin tube, cleanable type, mounted in sturdy base. Water control valve and pressure control installed. F-C Models 10 to 25 H. P. available. Models less condenser, from 5 to 50 H.P.

Our new foundry now makes deliveries on most models possible in one to two weeks.

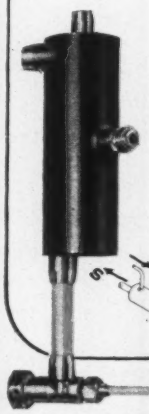
Write SCHNACKE, INC., 1020 E. Columbia St., Evansville, Ind., for complete details.

SCHNACKE, INC.



Automatic Liquid Feed
without Moving Parts

Injector with Distributor Head

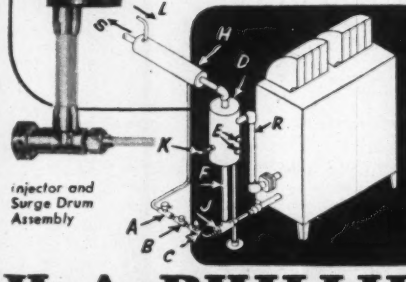


THE PHILLIPS INJECTOR provides completely automatic evaporator feed with *no moving parts*. By supplying recirculated liquid steadily to the evaporator it increases heat transfer and increases the evaporator capacity.

Many existing dry-expansion evaporators can be easily changed to Injector operation, with improved performance assured.

Adaptable to "Freon" applications, from air conditioning and water chilling to cold storage installations with plate coils, fin coils, and unit coolers. Injector capacities from fractional to 200 tons with "Freon". Furnished with either single outlet or distributor head.

Write for sketches showing typical Injector installations.



Injector and Surge Drum Assembly

FLOOR TYPE ROOM COOLER HOOK-UP
A—MAGNETIC SOLENOID
B—BULLS-EYE
C—HAND VALVE
D—SURGE DRUM
E—SIGHT GLASSES
F—LIQUID LEG
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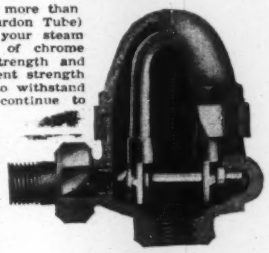

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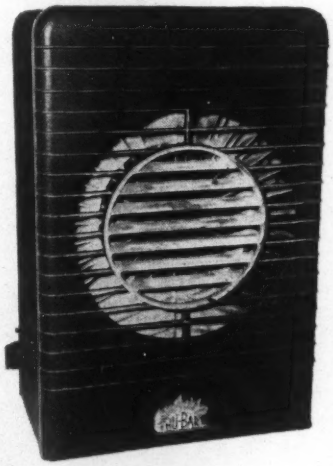

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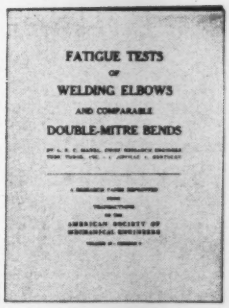

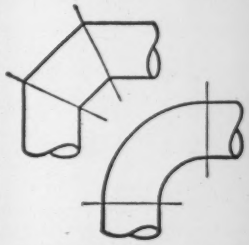

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